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NOTES AND COMMENTS.

Science and Commerce.

With the increasing number of technical associations and societies that spring up in almost every branch of industry, there often arises the somewhat delicate question of what relations should be maintained between those societies and commercial matters. The primary objective is usually improved education or capacity on the part of the members in their craft, and it is well appreciated that to allow a spirit of commercialism to dominate any such society, or to allow it to be exploited to commercial ends, is to nullify its power for good. The fact that there are existing many associations of a purely commercial nature which can claim to be very successful and useful may appear to contradict the foregoing assertion, but it must be remembered that the objective of the latter associations is very different from that of the technical societies, particularly in that the former's efforts are necessarily directed to their own immediate benefit and not the benefit of the trade or industry at large. The technical association, on the other hand, should above all strive to extend its field of usefulness to the farthest extremes of the industry with which it is concerned and offer the greatest help to the greatest number. Its primary object cannot be served by circumscribing its field of operations to a small selected circle. Moreover, although it may be claimed that the increased technical efficiency aimed at is for purely commercial ends, if commercial consideration are given first place, technical progress is usually greatly handicapped; for the commercial spirit is inherently far more short-sighted than the scientific or technical. Commercialism demands its return within measureable distance, and its efforts are generally directed to that end, and, moreover, to the service of the individual and not the community. The scientific spirit, however, disregards the question of immediate return, and sees its profit in the larger field of a benefited community, and it is this spirit that should, and generally does, dominate our technical societies. Naturally, instructions, benefit and improvement attained through this medium is applied to commercial ends as soon as opportunity arises; but the improvement and not its commercial possibilities is the first objective.

At the same time, the opportunity which the technical societies offer for pushing personal commercial considerations constitutes a great temptation to many, and there is scarcely a society that has not continually to resist this attempted exploitation of their organisation for some individual firm's benefit. This fact, however, is liable to engender a false sense of dissociation with commercial matters, and a tendency to avoid a certain necessary contact with the practical application of technical and scientific knowledge, which contact is required to give that knowledge its full effectiveness.

Moreover, the fact that an individual or firm presents before a technical society information in regard to his or the firm's own processes and apparatus

does not necessarily justify the charge of allowing the society to be exploited, even though the individual or firm may benefit by the publicity. It must first be ascertained whether the information imparted is such as will benefit the industry at large by its publication, or whether it will only create an incorrect idea of the value of the process or apparatus in question for the benefit of the firm. In the former case, the possible commercial object of the firm may be disregarded in view of the benefit derived from the information; but in the latter case there is no benefit to the industry, as the society is merely being made an advertising medium. It is as necessary to disseminate information as to the methods and processes employed by individual firms as it is to publish the advances of science—and often it is of far more practical utility and of greater educational value to know by what means a product may be made than to know its chemical composition to the third decimal point.

After all, though research and discovery may frequently be hampered by considerations of commercial utility, science only justifies itself by the commercial results it produces, or, in other words, by the assistance it renders in the operations necessary to the life of the community. There is a liability to overlook the fact that scientific knowledge, education and technical ability are only valuable when reduced to the use above-mentioned—when reduced to the basis of commercial factors. There is in some quarters a feeling that it is *infra dignitatem* for scientific personalities to enter the commercial ranks, but nothing could be more mistaken. That might be the case under some circumstances if the object were simply to employ the knowledge attained as a means solely to personal gain; but the step from the scientific to the commercial ranks is the culmination of scientific achievement. Commercial application is the touchstone to which all scientific research and attainment must be submitted before passing into the ranks of the useful. It is, therefore, desirable that the fact be not lost night of that science and industry must go hand in hand. While this is acknowledged in the abstract, there is, nevertheless, a strong tendency on the part of many technical societies to keep the two distinct and to assume a false air of detachment from all things commercial—and this while, as individuals, the members of those societies are, to their utmost ability, applying to commercial and personal ends the information and instruction received from the work of the societies. On the other hand, a very nice discrimination is required on the part of those organising such institutions, in order to ensure that they shall not become merely fields for exploiting commercial ideas for the benefit of a few individuals without regard to the service rendered to the industry at large. It is this latter necessity which has engendered the sense of detachment mentioned above, and to some extent obscured the limitations within which the commercial aspects of industry may be cordially encountered and acknowledged; and on this account the illogical attitude is somewhat excusable—though not the less illogical.

The Birth of the Bessemer Process.

It is proverbial that small causes and simple coincidences have far-reaching effects, but probably few to-day who are familiar with the Bessemer process of steel-making are aware how near the inventor was to missing his great discovery. In a recent issue of the "Journal" of the Cleveland Engineering Society, Mr. F. T. Wellman gives some interesting information on the early history of the Bessemer process, which he received at the time of a visit he made to Sir Henry Bessemer, in company with Andrew Carnegie. Bessemer explained that the reason he was first induced to experiment with a new process of iron-making was the knowledge that the Emperor, Louis Napoleon, was seeking a material to make better artillery than was then in use. Bessemer conceived the idea that he could make an improved wrought iron by blowing air through the liquid iron, instead of stirring it with a rabble to bring it in contact with metallic oxides, as was the practice in the puddling furnaces. To carry out this idea, he constructed a small stationary converter of firebrick, about 3 ft. inside diameter, and much more in height. The tuyeres entered at the side not much above the bottom, and were all connected with the blast box, which encircled the converter, a pipe leading from this to the blowing engine. The converter was covered and a hole in the side, near the top, was left as an outlet for the flames. When it was finished, he ordered a ton of pig-iron, stating no specification, but merely requesting pig-iron.

At this point chance dealt kindly with Bessemer, for he had no knowledge of the chemistry of iron or what composition was necessary to make good steel, and had practically any brand of iron been sent other than the one he received, the result would have been failure. But by good fortune the dealer sent "Blaenavon," the only brand made in England at that time that would have made good malleable steel with the conditions under which it was made. It was low in phosphorus and sulphur, high in silicon, and contained a little manganese. When this had been melted and dealt with in accordance with the experimenter's idea, it was tried in a neighbouring iron works and found to be rolled and hammered successfully. The bars were treated in many ways, both hot and cold, and proved to be so strong and tough that a great deal of interest was caused. The development of the process to its present state is a matter of common knowledge, but Bessemer said that if he had experimented with any other brand of iron made in Great Britain the result would surely have been a worthless metal, brittle and rotten at all temperatures, and that he would have abandoned the experiment at once. On such chances as this do the fates of nations and industries depend.

The "Stock" Oil-Fired Converter.

The oil-fired, side-blow converter introduced by Mr. G. J. Stock, which has been described and illustrated in previous issues, has now been installed in a number of steel-making plants. During the last two years, 13 installations have been made in England, two in Scotland, and single units are in operation in Belgium, New Zealand and Japan. Recently, the first American plant of this description was started at the foundry of Messrs. W. P. Taylor & Company, Buffalo, and the Dominion Steel Castings Company, Hamilton, Ont., shortly will place in operation a converter having a capacity of 2 tons. In addition, the Otis Steel Company, Cleveland, and the Otis Elevator Company, Chicago, each is installing converters of 2 tons capacity. The converter installed in the foundry operated by W. P. Taylor & Company has a capacity of 1,000 lbs. Owing to its comparatively small capacity, this converter is hand-operated and hand-tilted, the latter movement being effected by a hand wheel and a train of gears. The total oxidation losses average 16 per cent., including 6 per cent. for melting and 10 per cent. for blowing, but for a 2-ton plant these losses aggregate only 13 per cent. The oil consumption averages 70 gallons per ton for a 1,000-lbs. plant, and the total cost of labour, oxidation, electric power, repairs, oil, etc., approximates 23s. a ton. The net yield of castings at this foundry varies from 55 to 65 per cent.

British Foundrymen's Association

Lancashire Branch.

The fifth annual dinner of the members of the Lancashire Branch of the British Foundrymen's Association was held at Manchester, on Saturday, January 11. Mr. F. Penlington, President of the Branch, occupied the chair.

Additional interest was lent to the proceedings by a presentation in the course of the evening to Mr. H. Sherburn, in recognition of his services as Hon. Secretary of the Branch for four years. The toast of "The King" having been duly honoured,

Mr. J. Simkiss submitted that of "The British Foundrymen's Association and the Lancashire Branch." One object of the Association, he said, was to uplift the foundry trade and place it on a level with the rest of the engineering trades of the country; another was to train up and install into the minds of the young members of the craft the values and composition of the materials they used. By teaching them those values they would be able to avoid much waste work in future. He would like to suggest to each of the members, that they should occasionally bring one or two of the more intelligent youths in their foundry to the meetings of the Branch, for it would enable them to obtain a knowledge of the principles of the trade much earlier than they did under present conditions. It might also be the means of inducing a better class of young men to enter the craft, and to all such he would say "there is plenty of room at the top."

Mr. W. H. Sherburn, in responding, said that before the British Foundrymen's Association was formed, an idea very generally prevailed among foundrymen that the best policy was to keep any little trade secrets they possessed to themselves, but now that idea was becoming dispelled, to the great advantage of everyone, and particularly of those who made the discovery, through these foregatherings, that other men knew something as well as themselves. The constant coming together at meetings and in classes, and the privilege of intercourse with men of scientific attainments, had been productive of good all round.

The Chairman said most of them were aware that the Foundrymen's Association was initiated in Manchester, and that the Lancashire Branch had done much of the pioneer work of the organisation. During the last four years the Branch had progressed by leaps and bounds, owing to the enthusiasm, and the energetic work of the Hon. Secretary, Mr. H. Sherburn. The Committee and the members generally thought the present was an opportune occasion for making some recognition of the services rendered by Mr. H. Sherburn, and he had therefore on their behalf, and with much pleasure to himself, to ask that gentleman to accept the gift of a table centre. (Applause.)

Mr. Sherburn, in acknowledging his appreciation of the gift, said he would have been amply repaid for anything he had done by the enthusiasm now shown in the welfare of the Branch by so large a body of members.

Mr. Rhead proposed the "Lord Mayor and Corporation of Manchester," coupled with the name of Councillor Thewlis. He said the work of the foundry and of foundrymen was too often overlooked; indeed, they sometimes heard the inquiry by people unacquainted with engineering work—what is a foundry? Such persons were apt to draw the conclusion, when they saw the men coming out of the foundry, that it was some sort of a place where everybody got frightfully dirty, and that that reflected the kind of work done in it. (Laughter.) But appearances were very frequently deceitful, and in this case they were decidedly so. (Hear, hear.) The foundry was the beginning of the engineering workshop, and if things went wrong there, they went wrong all the way through. Turning to the subject of the toast, he said that while the municipal authorities provided classes in every other Branch of engineering, and in other subjects that touched industry, the foundry was practically neglected, or at any rate in only a very few instances was there a satisfactory equipment in any technical school for dealing with its practical problems.

Councillor Thewlis, in replying to the toast, said he was much obliged to Mr. Rhead for the hint he had given that the municipal authorities had not done all they might have done in forming classes such as he had indicated. He could only say that if he found it at all possible to provide the facilities they asked for, he could promise them he would do it.

Mr. Mills Palmer, in submitting "The Trade and Commerce of Lancashire," said we were at preesnt on the crest of the wave of a good time in trade. They must not lose sight of the fact, however, for it would have to be taken into account in calculating future movements, that the cost of production in pig-iron, as in other things, had greatly increased of late years.

Mr. Oliver Stubbs, whose name was coupled with the toast, said he thought everyone would admit that they in Lancashire had had a very fair share of the phenomenal increase in trade which last year witnessed. He would like, however, to point out that it was not the ironfounder who was making the large profits; they went entirely to the producer of the raw material. They could not to-day get a corresponding increase in the prices of castings in proportion to the advances they had to pay for the raw material. Since, therefore, they had to pay so much more for what they used, they were anxious to see what they could do to get increased production out of the foundries, in order to make successful competition possible. That was an important fact for all who were engaged in foundry work, to bear in mind. He was in full sympathy with the movement for better wages, believing the workpeople would be much happier when everybody received a more equal share of the wealth of the country. But at the same time, he thought such an Association as their own ought to see that the better wages and the shorter hours of labour were put to the best advantage. He would also urge that a little more attention should be paid to the junior members of the craft, than was generally done in foundries at the present time.

Mr. Hogg proposed "The Visitors."

Professor Carpenter, who acknowledged it, said that two years ago he mentioned when speaking at their annual dinner, that we were on the eve of developments in the educational facilities of the city of Manchester. He could now say that at the end of the present session in the University, they would have a full degree course in metallurgy, and Prof. Rhead was going to give lectures connected with foundry work. He had also a very strong hope that a foundry laboratory would in the course of time be erected outside the present University buildings, and he trusted they would send their men to take advantage of it. (Hear, hear.) They had to start under conditions as simple as possible, and gradually work up to dealing with complicated problems. It was a slow process, but it was the only safe way of working. (Applause.)

Mr. Gilpin, in replying for the practical side, said there was no craft that called for more skill than that of the foundryman.

Metals—Liquid and Solid.

Before the London Branch of the British Foundrymen's Association, on December 13, a very interesting lecture on "Metals—Liquid and Solid," was delivered by Dr. W. Rosenhain, of the National Physical Laboratory, Teddington. The lecture, which dealt with the properties and behaviour of molten metals during their passage from the liquid to the solid state, was illustrated by several practical experiments and a large number of micrographs.

At the commencement the lecturer remarked that as the subject was a very wide one he would confine his attention to those properties of metals of especial interests to the foundry, and would deal in particular with the vital process of change from the liquid state to the solid state. An abstract of the lecture is given herewith :—

A characteristic common to practically all liquids is that they are "simple liquids," *i.e.*, exactly alike in all their parts; and if the liquid is an alloy, it is a solution of one metal in another. An important property of all real solutions is that they always remain such until they solidify; there is no tendency for the heavier constituent to sink to the bottom. In this respect, alloys are like pure metals if all the metals in the alloy are really soluble in each other and are correctly proportioned.

[A simple experiment with sulphate of copper solution was made to demonstrate this point, the solution remaining homogeneous after mixing. This was contrasted with the behaviour of water and turpentine; when shaken up to form a uniform emulsion they immediately separate again under the action of gravity.]

Certain metals, however, though comparatively few, will not mix to form solutions. One example of this is lead in copper and the copper alloys, in which the former metal enters only as a mechanically contained constituent. In the case of metals other than those few immiscible ones referred to, when one metal is found at the bottom it may be taken as indicating that they were never properly mixed, although they may be quite miscible.

[The lecturer here illustrated by means of glycerine and water the difficulty of thoroughly mixing perfectly miscible fluids.]

This trouble is often experienced with molten metals in making alloys—so much so that the opinion is frequently expressed by practical men that remelting is necessary in order to get homogeneous metal. Repeated melting, however, has its disadvantages, and proper mixing in the first instance by means of a thorough stirring is better and will secure homogeneity.

Under some conditions want of homogeneity may not be due to improper mixing, but may be caused through the separation out of one constituent during solidification—a process known as segregation.

Liquid metal is chemically very active, and its activity is evident in its action on solid bodies, such as the crucible, skimming rods, stirrers, flux, and even the materials of which the mould is composed. With each of these the molten metal is liable to form combinations to some extent. As an example of this chemical activity it may be recalled that in steel-making by the open-hearth process solid ore is added to the metal in order to oxidise the carbon contained in the latter, the oxygen of the ore combining with certain constituents of the molten metal. In the basic-steel making process lime is largely employed to remove the phosphorus, the latter entering into chemical combination with the lime and going into the slag

This tendency of molten metal to combine with exterior elements, however, has serious disadvantages, as is seen in cupola working, where molten iron takes up sulphur from the coke. Liquid aluminium in particular is chemically active; it may attack the fireclay and combine with the silicon in that; it may absorb carbon from the crucible and stirrers (if of graphite), and it readily absorbs iron when in contact with that metal. But the activity of aluminium is more violent where gases are concerned, particularly oxygen; it readily takes up oxygen from the atmosphere, to the detriment of the metal.

The affinity of most molten metals for the oxygen of the atmosphere has caused serious thought to be given to the possibility of casting in an atmosphere free from oxygen, and it is probable that this will in the near future form one of the important advances in foundry practice. The action of oxygen is to combine with the metal to form oxides on the surface. If these oxides are insoluble in the metal they remain on the surface and form a coating which protects the metal from further contact with the atmosphere; but if, as is often the case, the oxides are soluble, they become distributed through the metal and contaminate it. When such contamination does occur, means have to be taken to remove the oxygen. With copper, which readily absorbs its own oxides, recourse is had to "poling," the use of charcoal, and recently the use of boron sub-oxide. The latter substance readily removes the oxygen, and unlike certain other additions does not to any appreciable extent affect the electrical conductivity of the metal, as high as 97 per cent. conductivity being attained. As regards aluminium, the oxides act to some extent as a protecting film. The affinity of the metal for oxygen is utilised in iron and steel manufacture, where aluminium is employed as a deoxidiser.

In connection with the effect of the atmosphere on molten metals, it is important to remember that carbon dioxide also acts as an oxidising atmosphere, and when metals are exposed to that gas in the process of melting in the furnace, oxidation may readily take place. Nitrogen is also absorbed by some metals, and while the copper alloys are comparatively free from its effect, aluminium, magnesium, and iron nitrides form very easily.

The gases present in a metal are not necessarily in chemical combination; they may be simply dissolved in the liquid metal at a high temperature. It is well known that the hotter most liquids are the less dissolved gas they will retain; water at boiling temperature, for example, quickly gives off its dissolved gases. But with liquid metals this rule is reversed; the hotter the metal the more gas will it take up. During cooling, the gases do not necessarily separate out, but may remain in the metal, where they then exist in a state of supersaturated solution. Since only a portion of the gases dissolved at a high temperature separate out during cooling, on solidification the residual dissolved gas is forced to separate from the metal, and thus forms blowholes in the castings.

Coming now to the question of freezing, the visible freezing temperature, or the point at which the crystals give out their latent heat of fusion, is marked by a temporary halt in the cooling of the metal. But the question arises as to whether freezing only commences at this point? It would appear that with some liquids, at least, the freezing occurs over a range of temperatures. Reference may here be made to Quincke's foam-cell

theory, according to which the different constituents should separate in the liquid state just above the freezing point. Experiments were conducted by the speaker to test the probability of this theory, the eutectic alloy of lead and tin being employed. The alloy was placed in the electrically-heated cups of a centrifuge and subjected to the centrifugal effect of 5,000 revolutions per minute, which should, by reason of their different specific gravities, have divided into distinct portions any "cells" or bubbles of lead or tin which had separated out in the liquid state. The results obtained, however, were purely negative, and did not in any way support Quincke's theory.

Solidification is nothing more or less than crystallisation, and the actual size of the crystals formed is accidental, being dependent on the rate of cooling. The minuteness of crystal formation which commonly characterises cast metals is simply due to the rapid rate of cooling restricting the growth of individual crystals. Crystallisation of a liquid commences at one or more nuclei or centres, from which the process continues rapidly, the best nuclei being small crystals of the substance itself. Metals of high purity can often be cooled well below their freezing points without crystallisation occurring. Pure metals are dependent on spontaneous nuclei to commence the process; but sooner or later they must freeze if cooled below the freezing point.

[The lecturer here demonstrated the process of crystallisation by means of a super-cooled solution of hypo-sulphate of soda. On the introduction of a minute crystal of the substance into the fluids crystallisation proceeded very rapidly, accompanied by the evolution of considerable heat.]

The fact that crystallisation must commence at nuclei or centres suggests that in melting metals, if the temperature is not raised much above the melting point crystallisation will be assisted during subsequent cooling by reason of the fact that the original nuclei may have not been entirely destroyed in melting. It is desirable for this reason also, not to overheat the metal.

In controlling the crystallisation of a metal or alloy, a fact to be borne in mind is that crystallisation proceeds against the direction of the heat flow, *i.e.*, from the colder to the hotter portion of the metal. The crystals which start from the different nuclei compete with each other for the uncrystallised fluid in the hotter portion, and their development is mutually restricted in this way, though often resulting in the structures interlocking. The strength, ductility and other physical properties are dependent on the structure of the crystal growth, a coarse, large, and ill-knit crystallisation being bad and giving little strength. Fine crystallisation which interlocks and interpenetrates the surrounding crystal structure is desirable as giving greater strength, and by quick cooling this structure is more readily obtained.

[At this point the dendritic structure of various alloys was shown on the screen.]

Only pure metals and the eutectic alloys have true melting or freezing points: alloys generally have a freezing *range*. This fact has an important bearing on the structure developed during crystallisation; for with a range of freezing temperature changes may take place in the constitution of the alloy, one constituent freezing before the other, giving a skeleton of solid metal with a liquid constituent filling the interstices, this liquid only freezing at a lower temperature. This fact has been turned to practical account by Prof. Hannover, of Copenhagen, who produces porous lead for battery and other purposes by centrifuging out from a lead-antimony alloy the lead-antimony eutectic after a portion of the lead has solidified.

During the process of solidification a perfectly homogeneous fluid metal may give rise to constituents of different composition, but in some cases on annealing these again diffuse into one another to form a homogeneous alloy. For this reason unannealed alloys are more subject to corrosion, since the separated constituents set up electrolytic action with the surrounding metal.

The few points touched on in the foregoing show the necessity of observing the interesting and important phenomena which occur during the process of cooling of a liquid metal to its point of solidification or complete crystallisation. An appeal was here put forward to the practical workers in metals to aid the investigations of science by recording the observations made during works practice. The scientist is largely dependent on the practical man for information regarding phenomena which are not frequently encountered in laboratory operations.

Discussion.

The CHAIRMAN (Mr. J. Oswald), in opening the discussion, referred with high appreciation to the research work of the lecturer, especially that in connection with the Alloys Research Committee of the Institution of Mechanical Engineers.

MR. A. WILLIS also expressed his keen appreciation of the lecture. There were one or two points, however, upon which he was not clear. It would appear from the lecturer's remarks that alloys were only mechanical mixtures; but he (Mr. Willis) thought a true alloy was the result of a chemical reaction. There appeared to be doubt in some quarters as to whether alloys were only mechanical mixtures or distinct chemical compounds. Further, the lecturer had suggested that alloys lacked homogeneity as the result of not being properly mixed. He (Mr. Willis) had found that one might stir an alloy indefinitely, if it were not correctly proportioned, and still segregation would take place. He considered that in certain proportions it was impossible to get alloys to give homogeneous castings.

MR. WOODS confirmed the lecturer's statements as to certain metals being immiscible. A homogeneous mixture of lead and zinc was not possible, while also lead and aluminium were very difficult to so mix. Further, in the better classes of brass and gunmetals he had seen the metals separate out into distinct layers, in the case of flat plate castings. Regarding the effect of gases, he had seen the head of a runner rise like a mushroom, and in such cases he condemned the castings before they were out of the moulds, for he knew they would be full of blow-holes. This he considered to be due to the furnace gases contaminating the metal.

A MEMBER asked the lecturer for his opinion on the use of the water-pot as a means of stopping the rising in the runner. It was a procedure sometimes employed with a view to saving the casting.

MR. BARTLETT remarked that in the case of blow-holes found just under the surface of a casting the lecturer would consider that the metal had been too hot. But he (Mr. Bartlett) found that it was better in such cases to pour the metal hotter.

A MEMBER asked whether the process of baring the diagonals of an open-sand casting in order to prevent cracking was correctly based.

DR. ROSENHAIN, in reply, remarked that there were more things in heaven and earth than science had dealt with, and could at the moment explain. Regarding the point raised by Mr. Bartlett, there were a number of causes of blow-holes, including the evolution of gases from the mould, which gases might become imprisoned in the metal. In such cases the hotter metal would naturally facilitate the escape of those gases, which would not have time to get through to the surface before setting were the metal duller.

This was an instance of the fact that the practical application of scientific principles was largely a matter of compromise between a number of opposing difficulties. In reply to Mr. Willis, he had certainly no intention of implying that alloys were only mechanical mixtures. The molten alloy, as a rule, was a *solution*, some of the constituents of which might separate out as independent constituents or even compounds on cooling. As Mr. Woods had remarked, however, there were some metals which were insoluble in each other at temperatures above the melting points, and in some practical alloys the limit of miscibility might be exceeded. Very complex alloys were often advocated, but he considered that three should be the greatest number of constituents, as the ternary alloys would give results as good as any of the complex mixtures, the special virtues of which existed mainly in the imagination of the inventor. He could only account for the separation of metals in the brass plates mentioned by Mr. Woods on the supposition that it was caused by the crystallisation proceeding from the flat surfaces, accompanied by a natural adhesion of the metal first crystallising to the surface from which they started. A longitudinal "pipe" might thus be formed down the centre of the plate and subsequent splitting would result. The diagonal baring of an open-sand casting mentioned by another member was a sound proceeding, but it was principally effective because it regulated the order in which the various parts of the casting cooled down. The exposure hastened the cooling along the diagonal lines and gave a sort of backbone to the casting, relieving the cooling stress. The somewhat heroic expedient of the water-pot on the header was not effective in regard to the casting; it merely solidified the head of metal and prevented the gases escaping. In such cases it would be better to adopt Mr. Wood's practice, and condemn the casting.

A hearty vote of thanks to the lecturer and his assistants concluded the meeting.

The "Ceries" Cupola with Pre-heated Blast.

In actual practice the ideal coke consumption in a foundry cupola is by no means attained. A recent attempt to bring ideal conditions down to practical lines has been made by the Céries system of pre-heating the cupola blast, described in "La Fonderie Moderne." The problem is to utilise the spare heat above that necessary for melting and send it into the coke or combustion zone. The air used for the blast is conducted to the cupola in such a way that it absorbs the heat given off by the walls of the cupola lining. For this purpose two metal rings are attached to the refractory lining of the cupola at a height above the melting zone. On the inside these rings form a part of the furnace lining. On the outside they are equipped with small coils of metal which absorb the heat, leaving, however, a space between each other and the cupola shell so that the air for the blast can pass through this opening. The outer shell of the cupola at the height of these metal rings is lined on the inside with refractory bricks to avoid radiation losses. The air is heated when passing through these metal coils and has a temperature of about 200 deg. C. when it finally reaches the tuyeres.

Thus, the temperature of the zone which produces heat is increased at the expense of the otherwise useless waste gases. The temperature difference between the melting zone and the zones lying directly above, is increased, so that heat exchange between the burning coke and the pig-iron in contact with the former is better and more effective. The height of the zone in which the temperature of the gases reaches above 1,000 deg. C. (with resulting decomposition of the carbon dioxide) will therefore be smaller. Tests made with these cupolas showed that if the blast was pre-heated to 100 deg., the coke consumption gave a saving of 9.6 per cent., while if the temperature of the air was raised to 200 deg., this figure rose to 19.2 per cent.

The second metallic ring at a lower level is provided with two rows of small rectangular windows which permit the introduction of a certain quantity of air into the cupola shaft. This air mixes with the combustion products, and brings them a certain quantity of oxygen, resulting in the burning of greater or smaller quantities of the excess carbon dioxide.

The heat produced by this secondary combustion process is employed to heat the upper zones and the upper metallic circle of rings. This double row of metallic rings and windows gives a double recovery of heat. The first and more important one is obtained by heating the blast air to 200 deg. The second recovery process adds 2,800 calories per lb. of imperfectly burned carbon. This latter heat would be entirely lost if the excess of carbon monoxide were allowed to escape into the open air. The saving, under favourable conditions, is said to amount to 30 to 50 per cent. for coke fuel. Apart from the above points, the new cupola has been equipped with the following devices:—

(1) Every tuyere is supplied from an independent opening in the blower, and each opening has a slide, which allows the air supply to be cut off. This permits a momentary relief of any tuyere that might be choked up by coke or by some piece of pig-iron which has passed the melting zone without being melted. All that is necessary is to close the shutter and the coke or iron piece will be immediately melted, since it is not cooled any more by the blast.

(2) The cupola shell is provided at the level of the lower metal ring with two sliding shutters, which lie on opposite sides. If for any reason the operation is interrupted and the blower stopped, the lower metal ring is liable to be heated to a dangerous degree, since it is not cooled any more by the cold draft of air. In this case the two slides are opened so that the metal ring is in contact with the outside air and is cooled.

(3) A so-called tilting crucible is fitted to the cupola, which serves the same purpose as the stationary fore-hearth. Its advantages over the stationary fore-hearth lie in small space for operation, small repair costs and a short tapping channel, which is easily adjusted and lined. This crucible varies in size and is suspended from a support in front of the cupola. It rotates on a horizontal axis and has a slag and tap channel. The roof of this crucible is formed by the cleaning door of the cupola. The latter rotates on an axis, and can be lined with a refractory lining so as to form a good cover for the crucible.

The Corrosion of Bronze Propeller Blades.

According to Ramsay, the remarkable corrosion of propeller blades used with steam turbines is probably a result of electrolytic action. That part of the blade which is exposed to great strain becomes anodic while the normal part becomes cathodic and in the electrolyte (salt water) a current flows between them. The hardened or strained metal is attacked, or dissolved, and the unstrained metal is comparatively unaffected. It is considered that the reduction in weight of the propeller blade has been too great; it should be stiffened enough to prevent flexure.

Making Flange Pipes with Branches, in Loam, Vertically Cast.

By Sidney G. Smith.

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The following method of moulding flange pipes in loam, applies to pipes of 30 in. diameter and upwards, with one or more branches of varying diameter not above 12 in. long. These can be fixed in any position required. Pipes up to 12 ft. long may be made by this method. For pipes less than 30 in. diameter, it is not convenient to strike up the whole length in one piece.

The following method saves pattern-making, produces a sounder casting than when cast horizontally in sand, and entails very little extra cost in the foundry, if the necessary casting pit and lifting power are available. The writer has fixed upon a medium diameter of both pipe and branches, and gives the dimensions of all tackle when cast, in order that it may be intelligible to any who have not had experience in this kind of work. Fig. 1 is a sketch of the casting required. Fig. 2 shows in section the assembled mould complete. Each piece of tackle is lettered, so that reference to Fig. 2 will show the location of the details depicted in the other illustrations.

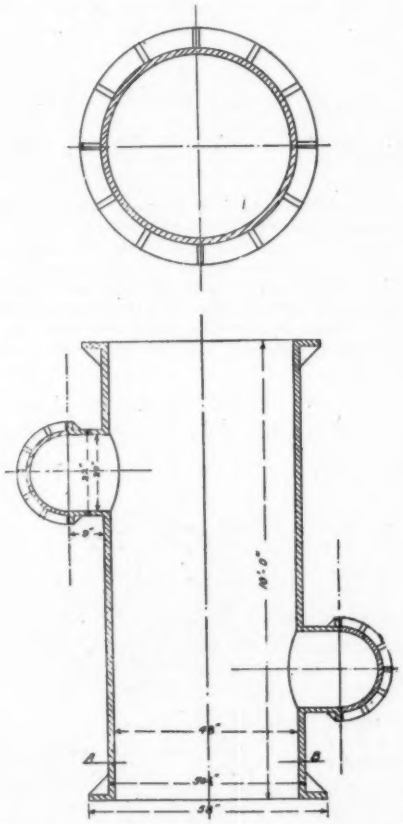


FIG. 1.—PLAN AND SECTION OF PIPE WITH BRANCHES.

It is an open question, taking all things into consideration, with a casting such as the one shown, whether it should be rammed up with sand in a casing of rings, or a large amount of binder tackle made sufficiently strong to stay the mould and resist the pressure and strain of iron during pouring. The writer is of the opinion that the former in this case is the safest, most convenient, and most economical; even if rings have to be made they cost very little, being plain, open-sand castings, with an allowance of from 2 to 4 in. each side for ramming, and about 12 in. deep. A mould of this length and diameter could be put together (if dried and dressed), rammed and cast the same day.

The body core is shown as a bricked one, because a core barrel of the diameter required is not always in stock, and is rather an expensive piece of tackle to make for one or two pipes only; but where a core barrel is in existence the core is less expensive, being plain, than a bricked one, although in the present case it is possible to build and strike the core in one day. If the core barrel is used, slot holes must be cut out in the proper position for the tee-headed bolt

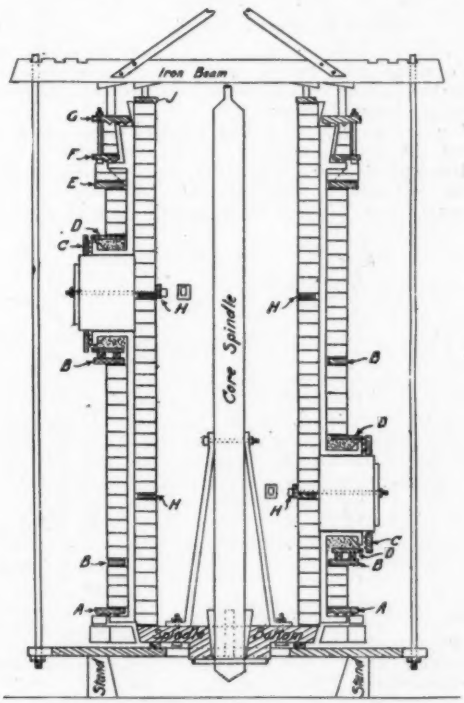


FIG. 2.—SECTIONAL VIEW OF ASSEMBLED MOULD BEFORE RAMMING.

to anchor the branch cores (see H, Fig. 2). A description of the core spindle and spindle bottom are not given, being detailed in former articles.

The completed mould is held down by slings from the bottom plate to packings on top head G, and top plate J, Fig. 2, with an iron beam or cross. If it is inconvenient or ungainly to hold down with slings, the mould could be securely cramped together, which, of course, in either case is done after the mould is rammed.

Fig. 3 (A, Fig. 2) is the prodded cake plate to cover the bottom flange. It is practically cut in halves with flat cores when cast, and a fish-plate template is used for setting four 1-in. round cores at either side. Before being struck up with loam it is split and fish-plates bolted in as shown. The bolt nuts are unscrewed at one side when the casting is being stripped and taken out, thus liberating the plate in halves, which can be bolted up and used again for the next casting. Twelve recesses are cast in the plate for the brackets. The prods for holding the loam are 1 in. long. When this plate has been struck up and dried, the brackets are correctly marked off with a trammel, cut out, blocked, and the plate turned over and slung with three staples which have been cast in for that purpose.

Fig. 4 (B, Fig. 2) is the plate to carry the branch box and brickwork. For this casting two of these are required, as both branches are the same size, right and left-hand. The enlarged part of the plate is for resting the branch box upon, which is set on four packings the exact height required for its position, and afterwards squared and checked accurately. This plate is also cut partly through with cores when cast, and if split through before making the first casting is held together by two small cramps. There is no need to bolt this plate together, as there is brickwork underneath and above it; the cramps are just put loosely into 1-in. holes at 6-in. centres These dimensions are standard, so that the same cramps can then be used for any similar work. It is necessary to have the plate in halves to release it after the pipe is cast; it can then be used again, which plan saves re-making such tackle.

Fig. 5 (C, Fig. 2) is the prodded cake plate for the face of the 22-in. branch, being required for each

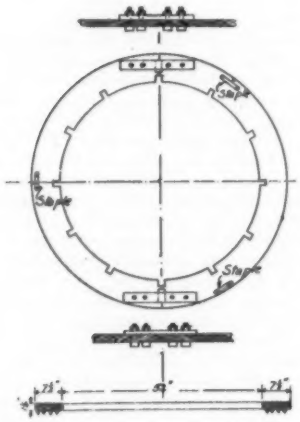


Fig. 3.—Plate to Cover Bottom Flange (A, Fig. 2.)

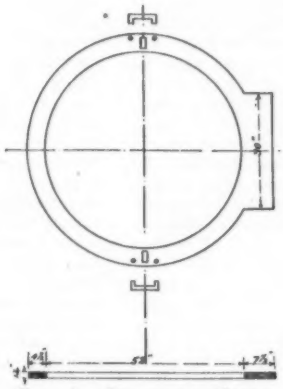


Fig. 4.—Plate to Carry Branch Box (B, Fig. 2).

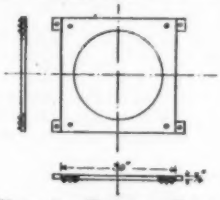


Fig. 5.—Branch Cake Plate (C, Fig. 2).

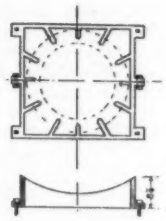


Fig. 6.—Branch Box (D, Fig. 2).

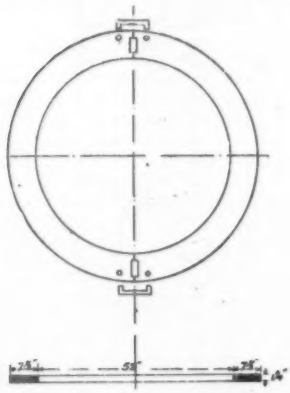


Fig. 7.—Plate to Carry Brick-work of Top Flange (E, Fig. 2).

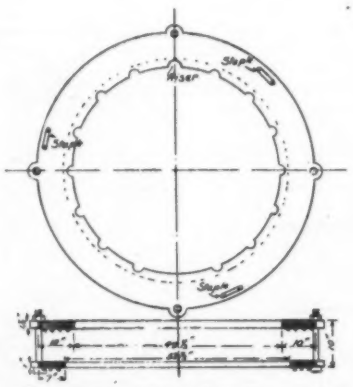


Fig. 8.—Feeding-Head Plates (F & G, Fig. 2).

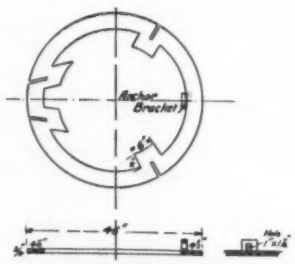


Fig. 9.—Core-Binder and Anchor for Branch Core (H, Fig. 2).

branch. This plate is struck up and dried before the branch pattern is put on; four holes are cast in for vents, and the lug holes should be drilled. Clearance of ½ in. in the centre hole is allowed. Fig. 6 radius wood set-square for setting the branch box on plates B. The set-square is made the same size as the outside diameter of the branch; it should be a good fit, the length being from the outside of the

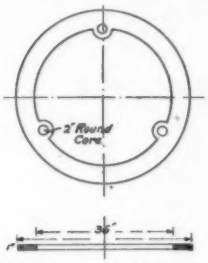


FIG. 10.—TOP PLATE FOR CORE (J, FIG. 2).

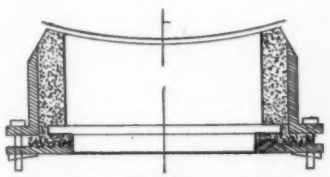


FIG. 11.—ENLARGED VIEW OF BRANCH BOX WITH PATTERN DRAWN.

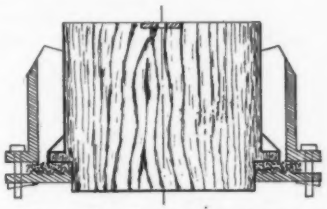


FIG. 12.—ENLARGED VIEW OF BRANCH BOX BEFORE BEING RAMMED (C & D, FIG. 2).

(D, Fig. 2) is the branch box, made in two halves and bolted together before ramming. When stripping, the bolts are taken out and the box in halves is released, and can again be used. The length of this branch box is determined by the length of the branch from the outside of the pipe, less ¾ in. for mould, and should correspond with loose fingers on the mould striking board when properly set, and flush with the board after plumbing.

Fig. 7 (E, Fig. 2) is the plate to carry the brick-

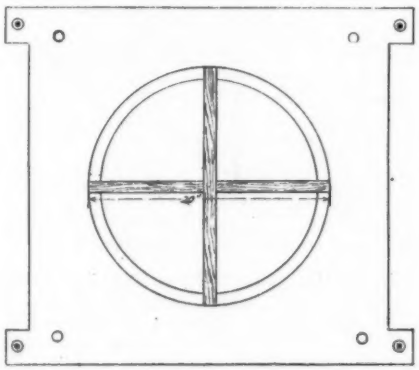


FIG. 13.—END PLATE OF BRANCH BOX WITH SET-SQUARE.

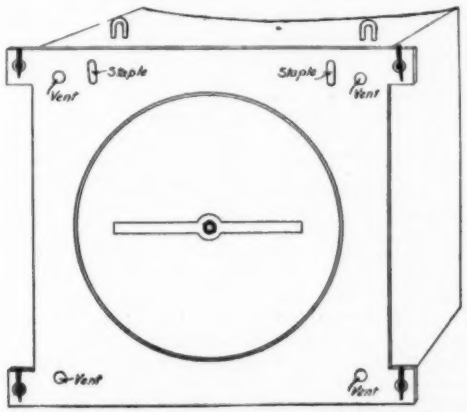


FIG. 14.—VIEW OF BRANCH BOX AND CAKE PLATES (C & D, FIG. 2).

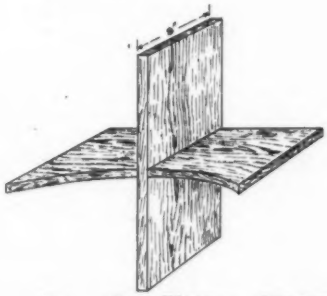


FIG. 13a.—WOODEN SET-SQUARE FOR SETTING BRANCH BOXES.

work of the top flange. It is partly cut in halves when cast, the same as plates A and B, and is held together with two loose cramps when split, and put upon the brickwork. Fig. 8 (F and G, Fig. 2) shows the feeding-head and runner-gate plates, which are bricked and bolted together as shown. Flat runners are filed into the half-round recesses cast in the plate. The striking board for the head plates has been described in a former article. All plates for the outside of the mould (A, B, E, F, and G) are made to allow an inch clearance from the mould board for loam. Fig. 9 (H) is the core binder and anchor for

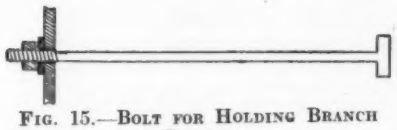


FIG. 15.—BOLT FOR HOLDING BRANCH CORE.

loam clearance at the inner end. Figs. 11 and 12 give enlarged views of the branch box and cake plate, with branch pattern fixed before ramming, and after being rammed and the pattern drawn. The branches are rammed with milled sand, or partly dried loam, and are dried or par-dried before being built into the brickwork.

Fig. 13 shows an end view of the branch box and

the branch core. One is required for each branch. This binder stays the core brickwork, and the lug with rectangular hole cast in is for bolting fast the branch core (see H, Fig. 2).

The great advantage of this method is that it does

away with the use of chaplets, which for many reasons are objectionable. It is always a wise plan when making pipes, cylinders, or any other castings that have to stand pressure, to avoid chaplets wherever practicable. It will be noted that the core binder is made partly cut through from the outside

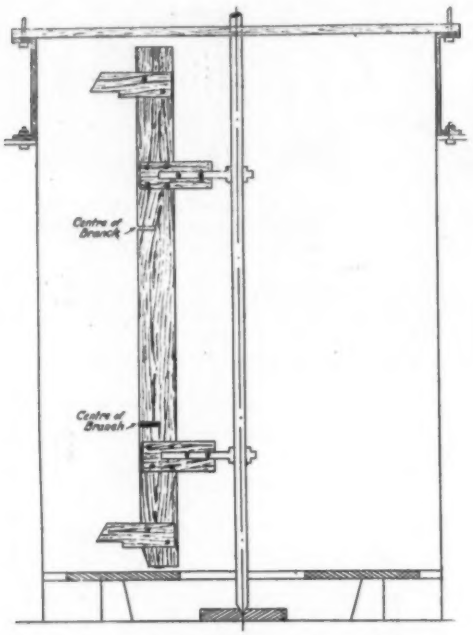


FIG. 16.—MOULD BOARD, SHOWING BRANCH CENTRES.

in four places, with flat cores, two of the cuts forming a key, and when the casting is poured and set it is split with ease through the unbroken part, and removed in order that a course be made to cut the brickwork for contraction. This same binder could, if the other branches were opposite, or nearly so, anchor more than one core; it would simply be a matter of putting the lugs in the right positions. To allow the contraction to come in evenly, each cut in the binder must be broken through, which

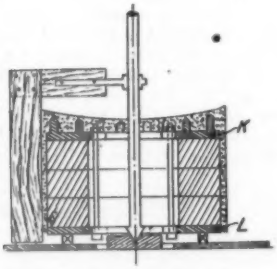


FIG. 18.—BRICKED BRANCH CORE.

necessitates, at any rate where branch cores are to be held, a new binder for each casting.

Fig. 10 (J) is the top plate for the core; the three lugs with holes cast in are for handling with a small three-legged chain. Considerable weight is put upon this plate when fastening together the mould, especially if the core is a taper one with the large end upwards. Fig. 14 (C and D) is an enlarged back view of the branch box and branch cake plate bolted and cottered together. Fig. 15 is the tee-headed bolt for holding the branch core. Fig 16 is self-explanatory;

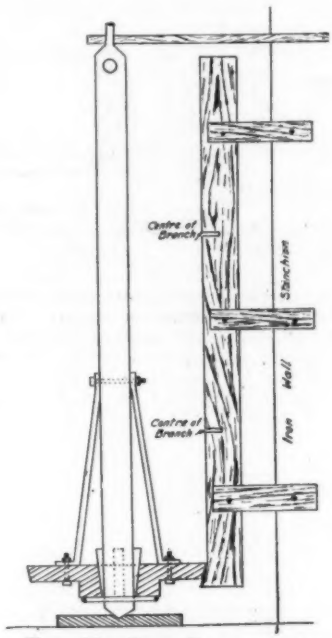


FIG. 17.—CORE BOARD, SHOWING BRANCH CENTRES.

it is simply the set mould board, with the branch centres indicated to which the branches are set by means of the radius set-square already mentioned. Fig. 17 also explains itself. It is the core spindle and bottom set into position with the core board, showing the centres of the branches which are the guides for placing the plates H, H, with the lugs on for holding the branch cores upon the brickwork. When bricking the core, wedge-shaped pieces are put through the brickwork when the centres are reached.

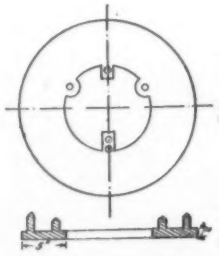


FIG. 19. — TOP PRODDED PLATE, K.

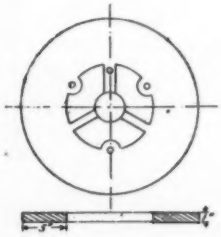


FIG. 20.—BOTTOM PLATE L OF BRANCH CORE.

The branch core may be made in a core-box rammed with milled sand, a loose wooden block shaped to the radius of the main core being put in the bottom. This branch core should be strengthened with iron rings and rods, to stand the bolting up to the anchor

lug when being fixed. A hole, not less than 6 in. diameter, should be run through the middle of the core for handling the bolt and stopping in at the radius end of the core. Or a thick loam core with bands may be made on a core barrel, taken off and the radius shaped with a template. If the branch core be a large one, it will be necessary to make a

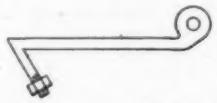


FIG. 21.—BRANCH CORE SLING.

bricked one, as shown in Figs. 18, 19 and 20. The core could be made the reverse way to that shown, if a dummy radius bottom is made and dried to build upon; in either case, a plain or radius dummy will be required for the true working of the core board. In the case of a bricked core, which with the bricks and the iron plates will be a considerable weight, a special sling should be used, similar to that shown at Fig. 21.

British Foundrymen's Association.

First Annual Dinner of Birmingham Branch.

The Birmingham Branch of the British Foundrymen's Association on Saturday, January 18, held its first annual dinner under the chairmanship of Mr. H. L. Reason (President of the Branch). A very enjoyable programme of musical and other items was given by members and visitors. The arrangement of the programme was in the hands of Mr. H. Winterton.

After the loyal toast had been duly honoured,

MR. S. W. B. STEPHEN proposed "The British Foundrymen's Association." He reminded the members that the Association was formed only nine years ago, so that it was still in its infancy, and had, as they all hoped, a long way to go. The educational value of an institution of that character was inestimable. The old-fashioned rule-of-thumb had quite gone by the board, and foundry work was now a combination of theory and practice, and that was what made for success. A quality which seemed to be characteristic of the British foundrymen was confidence. He remembered pointing out with some little pride that a particular coke had been employed in making a certain casting of about 30 tons, but he was told by their Past-President that he had made a great mistake, that it was a most excellent casting, but that the credit of that casting was due solely to the foundryman. (Laughter and applause.) No doubt if the casting had been a bad one it would have been the coke. (Laughter.) He coupled with the toast the name of the President of the Association (Mr. C. Jones) and that of Mr. Buchanan, a Past-President.

MR. C. JONES, in responding, said that he must thank Mr. Stephen very sincerely for his sympathy. Mr. Stephen had remarked that perhaps they were rather backward in starting, but they made up for it by their enthusiasm and earnestness. There was a good deal in that. Generally speaking, he did not regret that that Association had been long in commencing. They could truthfully say that though the Americans started first, the British foundrymen had a better organisation. They went in for educating the younger men; the older men, like himself, were too old to learn much, but they could help the young ones who were coming along, and would do for them all that lay in their power. The country belonged to them, and they belonged to the country, and it was every man's duty to do what he could to advance the industry to which he belonged. The Council, especially in Birmingham, had done its best to make the running for the young men, and had fixed the subscriptions so that all could join. Therefore no young man could say now, as he when a young man might have said, that he had no chance at all. The other Branches were as earnest as was the Birmingham Branch. Their methods might be different because the work and the circumstances were different, but they all had one object in view, and that was mutual advancement.

MR. R. BUCHANAN, who also responded, remarked that he had forgotten, till Mr. Stephen mentioned it, the incident of the big casting and the coke. It was, however, perfectly true that he (Mr. Buchanan) said that the making of the casting was due to the foundryman. He also hinted that if there were anything wrong about it, it would be due to the coke. (Laughter.) It was necessary to keep the commercial gentlemen somewhat humble, because if they thought one was too well pleased they had the bad habit of running up the price of what they supplied. After all, he thought no foundryman was likely to get too conceited about his work, because he had in his daily procedure sufficient to induce a chastened and humble frame of mind. He had never yet met any man really a foundryman, who professed to know more than a tithe of what the business contained. It was very gratifying to him recently to hear an employer who was both an engineer and a foundryman say, "It is astonishing what a position the foundryman has taken during the last few years in the general estimation of the engineering world." That remark showed, not only that they were making on impression upon their fellow workmen, but also that in the engineering world generally an impression was being formed that there was more in founding and foundrymen than used to be thought. (Applause.) The foundryman was beginning to realise how much he had in his own hands the status of his trade.

MR. R. J. RABY proposed "The Birmingham Branch," remarking that he thought it an excellent thing that the papers that were read dealt not only with the scientific or theoretical side of foundry work, but also with the practical side. That Association, he believed, was the only one in which matters were dealt with so exhaustively, and in which the practical side received so much attention. Touching the question of pig-iron, scientific analysis of pig-iron had become an absolute necessity for successful foundry practice. He did not altogether disregard fracture, but no man could judge the exact value of pig-iron from fracture alone. The buying of pig-iron by name was a very old-established practice, but it had now given way, in the case of all up-to-date foundries, to buying by analysis. (Hear, hear.)

The CHAIRMAN, as President of the Birmingham Branch, responded to the toast proposed by Mr. Raby. That gentleman had overlooked the fact that their Association had just entered on its tenth year. Although they were of tender age, they were strong in youth, full of energy, work and enterprise. (Applause.)

MR. WINTERTON proposed "The Officers of the Birmingham Branch," which was responded to by MR. G. HAILSTONE, and MR. PEMBERTON then proposed "The Visitors and the Artistes," to which MR. HATELEY and MR. SKIDMORE replied.

The toast of "The Press" and "The Chairman" concluded the evening's entertainment.

Mishaps and Recoveries in the Foundry.

The members of the Halifax and District Branch of the British Foundrymen's Association held their third meeting of the session on Saturday, December 21, in the Municipal Technical College, Halifax, when a lecture was given by Mr. James Gaunt, of Leeds, entitled "Mishaps and Recoveries."

MR. GAUNT said he considered that mistakes or mishaps presented the most interesting problems the foundry held, and an inquiry into the causes could not fail to be useful. These mishaps were very often due to causes which were looked upon as exceptional or accidental, but even in such cases an analysis of the mishap would often show the methods tending towards a repetition of such mishap.

A Contraction Problem.

Quite a large proportion of the difficulties encountered in the foundry arose through faulty design and the trouble due to contraction which naturally followed. In many cases, especially where the casting in question was a large one, the trouble would be overcome by such means as baring and chilling thick sections and thickening up the thin sections. He had seen a casting of faulty design where baring and chilling were of no avail, and when any alteration of design, sufficient to meet the case, would have resulted in an unsightly casting. The trouble arose through the placing of a very heavy boss on a comparatively light hand wheel, the wheel being of 7-in. diameter, with a 2-in. boss ½ in. deep on the top side, and a 4-in. boss 1½ in. deep on the underside, with a ¾-in. core running through. The arms were ½ in. thick, and the rim of the wheel ¾ in. diameter. In order to counteract the effect of the heavy boss on the contraction of the wheel, baring the boss and removal of the core were tried, but did not remove the trouble; every wheel upon which this method was tried came out with cracked arms. Chills were then rammed up in position around the boss and one or two of the wheels in this case were passed as far as the fettling shop, only to meet the same fate as the others. Personally, the lecturer contended that if all patterns could be designed so that all parts of the casting cooled down together, contraction stresses would be entirely removed. In order that this regular cooling might be effected, the castings, as soon as they were set, were removed from the boxes with the sand still adhering to them and were placed on the hot bed of the freshly-drawn receiver. By this means no part of the casting could cool quicker than the receiver. Not one of the castings so treated showed any sign of stress, even under the most stringent tests.

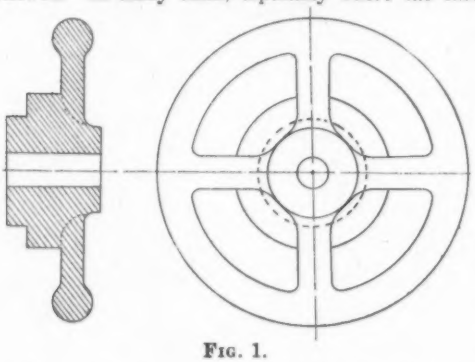


FIG. 1.

Grate Troubles.

The use of grates as a means of lifting out depressions and cavities is largely followed in British foundries. The lecturer said he preferred the use of gaggers; still, cases arose where grates were the most handy and economical means of lifting out such parts. It was not often in dry sand one came across a mishap due to the grates used; but a broken grate led to the mishap next to be discussed. Whatever might be the strength of the grate, he was of the opinion that faulty scotching led to more breakages than any lack of strength in the grate itself. How often one came across the type of grate illustrated in Fig. 2. He had no hesitation in saying that the design was not perfect. It would be noticed that the three long prods cast on to facilitate scotching were placed well inside the staples. When the grate was bolted up, the prods constituted a source of danger, as during the tightening of the bolt hooks they set up a strain on the grate which might at any time be strong enough to cause breakage. The moulder when excusing himself for the break, might say, "I only screwed it up until tight." But could he tell by means of the bolt hook when it was tight? Cast iron had a good deal of spring in it, and when the moulder was not pulling directly upon the scotching, a certain amount of this spring was taken up by the bolt hook. The grate would feel just tight when we had reached a stage approximating almost to breaking point, and any extra turn on the bolt-hook or any extra strain on the grate would lead to breakage. But no experienced moulder would scotch a grate in the centre only. He would have his scotchings nearer the end as shown in the diagram B (Fig. 2). In such a case this would tend to minimise the trouble, but would not entirely eliminate it. The only way to safely fasten a grate was to have the scotches side by side with the staples. Then immediately the bolt-hooks were tight, the force exerted on the scotchings would be a crushing one, and as cast-iron offered very great resistance to crushing stress, the moulder could not put any into the grate itself. This eliminated any tendency to break.

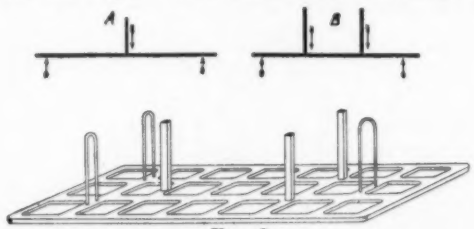


FIG. 2.

The mishap before-mentioned occurred on an engine baseplate. The interior of the bed was lifted out as usual and finished overhead, all being well up to this point. During the drying of the mould, the extra strain due to the expansion of the grate was sufficient to cause breakage, and the morning after the drying the top part was discovered with the broken grate, and that portion of the mould surrounding it in anything but a fit state for casting. What was to be done with it? The rest of the mould was in perfect condition for casting, and it was only necessary to replace the damaged portion in order to save the expense attached to the remaking of the job. This was done in the following manner:—A

core was made from that part of the interior of the pattern corresponding to the damaged portion of the mould and dried. In the top part of the mould the broken grate was removed, and the sand above it taken away to the joint level, and the bars of the box dug out, leaving just sufficient sand to form a bearing for the new core. This core was then placed on the floor between stands set to receive the top part and in a position approximating to the one it would occupy in the top part. The top part

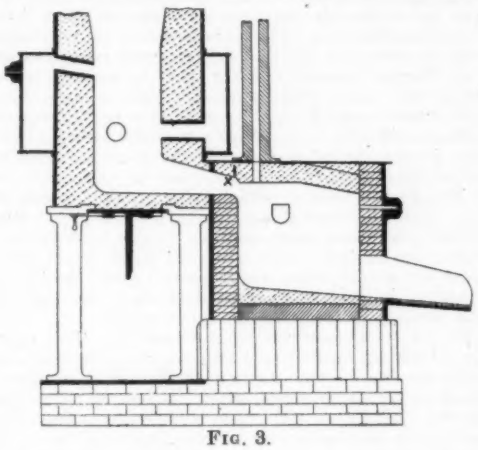


FIG. 3.

being then lifted on to the stands, the core was lifted into position by means of the crane and securely fixed by bolt-hooks. The portion of the top part which had been cut away was then made good and the job was ready to cast.

A Study in Receivers.

One of the greatest objections which some founders had against the receiver type of furnace was the cost of upkeep. He (the speaker) had not found this excessive when compared to the advantages derived from its use. It was not his intention to enter into the merits or demerits of the receiver, but to call attention to one phase in their design which led to mishap, and to describe the method adopted to rectify this. To his mind, one of the greatest faults of the receiver furnace was in the construction at the point where the metal as it leaves the furnace flows through the channel into the receiver. The point is marked by a cross on Fig. 8. The channel and roof here were subjected to rough wear, caused by the scouring action of the slag and blast upon the lining of the channel. If not very carefully watched the roof would wear away at that point. Why should not the channel enter the receiver at a point some distance down the side instead of the roof level? At his works some six months ago this wearing through took place about 15 minutes after the blast was put on, and a goodly portion of the ironwork was quickly melted away. After stopping the blast a good daub of gannister was placed round the hole, and a plate secured, which was also gannistered, this being put on the ring of gannister and weighted down, as shown in Fig. 4, and this held until the blow was nearly over. This was only a temporary job, and a permanent repair was made as follows:—(Fig. 5) A plate was made to cover the hole in the middle to take a bolt. Another plate was made with prods similar to those of a loam plate. The prodded grate B was held in position under the hole inside the receiver, whilst the hole C was filled with a mixture of gannister and fireclay ground in a mill. The top plate was next put on and bedded to the gannister, and a bolt passing between the two held them together. The prodded portion forming the roof was filled with the gannister and fireclay mixture, and had held good ever since.

A Broken Box.

The more nearly the shape of a box approximates to the joint line of a pattern and the bars to the contour of a pattern the more efficient the box becomes, and a box which exactly fits such a joint line and contour is a great aid to output. This, said the speaker, led to some weird looking boxes being placed on the foundry floor, in many cases without thought as to the working strength of such parts.

Fig. 6 illustrates a box for a large bed, the dimensions for which were 10 ft. by 4 ft. 6 in. The bottom portion of the box consisted of an ordinary top part with two openings, one at each end, to allow the feet of the bed to come through in order to do away with what otherwise would have been an 18-in. lift. In these open ends, bars were wedged which followed the outline of the pattern and joint, thus making two huge pockets and joints as shown in Fig. 6. The same efficiency could have been obtained by making these pockets loose, just like two deep boxes, just to take the feet and fitted by means of pins and lugs on to the top part. These pockets could then have been removed separately and turned over for finishing by means of swivels, leaving just an ordinary flat top part to be lifted afterwards. With the design illustrated there was always risk in lifting the box, owing to the heavy ends, which also prevented the box from being turned over, while all finishing had to be done overhead. The job with which the mishap occurred was finished and tried on

FIG. 4.

for the first time, but on lifting again to see if any crushing had taken place the box suddenly broke in the centre at the point marked A, when about 1 in. from the ground. The job might have been cast and the risk taken, but the best plan was to find some means of lifting the box to see that everything was right. The was done by obtaining a 2-in. square

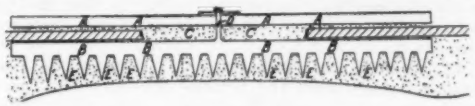


FIG. 5.

bar, marked B (Fig. 7), and cramping it onto the flange, as shown. The box was then lifted, the mould repaired, and cast.

A Core which Saved 1,000 Times its Own Cost.

This was a case where a simple piece of oil-sand jobbing core saved a great deal of friction between producer and buyer, and a great deal of labour which would otherwise have been spent on the job. A youth in fastening a core in a top part had, by attempting to fasten too tight, pulled the core right through the top. The bottom part of the mould was ready, and they were just waiting for the closing of the mould to put on the blast. Fig. 8 shows the job itself in the vicinity of the affected portion, and also shows how it was handled in order to cast it the same night. The top part round the point of the core was cut away, and also the thickness of the

casting at this point. On closing, this left a hole larger than the core, and into which the core was lowered to position leaving a space all round representing the thickness of metal in the casting. This was covered by the jobbing core, rubbed to the desired shape. The hole in the top part was then

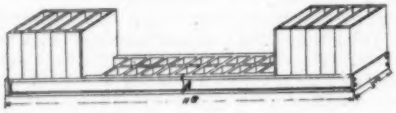


FIG. 6.

filled up, and the sand above it levelled off and a flat weighted plate placed upon it and scotched under the weight. A complete and safe recovery

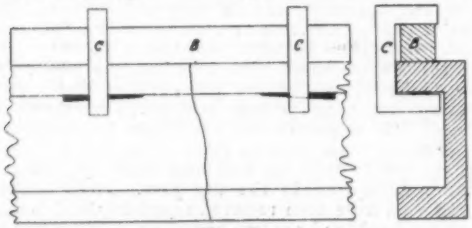


FIG. 7.

was made, involving very little more expense than if the job had gone through without mishap, and certainly with no extra risk attached to it.

Discussion.

MR. HANSON asked, did Mr. Gaunt wish to imply that the grates shown in his drawings were the usual design he had met with, or were they extreme illustrations used to more fully reveal their weaknes? Personally, he had never seen grates like those referred to in any shop at which he had worked. He did not think any experienced moulder would cast fast scotchings on to a grate regardless of the convenience for wedging same to the bars in his top part. He agreed with Mr. Gaunt that the best place for scotching grates was as near as possible to the staples and not in the centre of the grate. The broad flat bars shown in the design were also contrary to practice, if good results were to be obtained by a grate carrying sand near the face of the mould. He preferred deeper bars and narrower ones.

MR. BERRY remarked that in respect to Mr. Gaunt's trouble with the balance wheel, he had cast thousands with bosses large and arms thin, thus causing unequal contraction. He got out of the difficulty very nicely by strengthening the arms and baring the bosses. He hoped to try the method suggested by Mr. Gaunt with some covers which were very awkward in shape and in thickness. He would not attempt to lift the box illustrated with clamps, but would have rings or handles at equal distances from each end and turn the box on swivels. Regarding grates, along with Mr. Hanson, he must say he did not like them; no grates of that style should be used in green-sand work. Personally, he did not care to use the straight-sided grates at all, but preferred the sprayed grate with a gagger between each spray. With regard to the scouring of the receiver, his difficulty had not been with the top but with the bed.

MR. ROBINSON stated that practically he was without receiver trouble; the channel would occasionally make up, but that was overcome by cleaning out every week. With regard to the permanent repair of the receiver top, they were on one occasion without top altogether. He tried a similar expedient to Mr. Gaunt's for a temporary covering, but found that the gannister did not last long. Now they had an ordinary arch built by the bricklayer, which did not show any sign of wear, although it had been in operation two years. When this alteration was made, they had the receiver made oval in shape, thus getting a more compact body of metal and less surface for oxidising and cooling.

MR. STACEY asked if Mr. Gaunt preferred the use of gaggers to grates where the lift was a deep one; also he would like to know what course the lecturer recommended when using a rather dull or dirty metal and the receiver became full of slag, and the slag hole became choked. He thought the channel between the cupola and receiver was a very weak spot, and it was high time a remedy came from the maker. Almost every time a receiver broke out, it was just at this point at the back of the receiver where the channel was connected.

MR. SMITH said he thought the trouble in connection with the base plate might have been overcome without throwing the casting a day later, when the grate was broken. If the top had been bored through in two places, fresh hooks put on the broken grate, it might have been pulled back into position and made good for the same day's cast.

MR. GAUNT, in replying, pointed out that at no time in his address had he referred to the grate as being an ideal one. He agreed that the best design of grate for green-sand work should be deep and narrow. Some of the members present had suggested the strengthening of weak arms to overcome construction stresses in unequally designed wheels or pulleys. This was alright when making castings for their own use, but in the case referred to he was making for a customer and was compelled to supply castings as per pattern. The reason why he had brought that drawing of a moulding box was to point out the necessity in many cases for consulting practical moulders before designing a box part. Much inconvenience and loss of time and money would be saved if this practice was adopted more generally. He could not give any standard of life for a receiver bed. It should be made good as often as required.

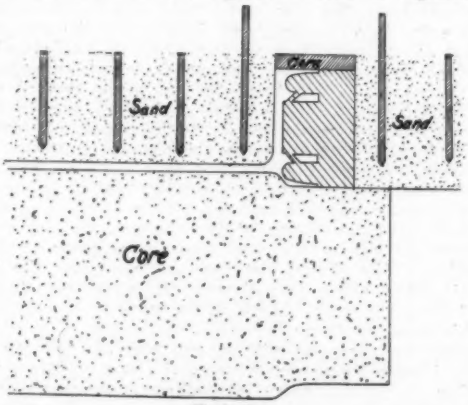


FIG. 8.

In case of deep lifts, in some cases grates were better than gaggers; that must be left to one's own discretion, wherever possible, as he had said before. He preferred the use of gaggers, but when the lift was too deep and the box bars narrow the continual placing of gaggers, one row after another was apt to choke up the bars and leave no ramming space. In a case like that he would use grates.

A hearty vote of thanks was accorded to Mr. Gaunt for his Paper..

The Casting of Aluminium.

Despite the increasing demand which is being made by many industries for castings of great strength and lightness, due attention does not seem to be paid to the possibilities before aluminium. In some branches of engineering (in motor car construction, for example) aluminium has been largely adopted, but even when such is the case, proper care is frequently not given to the selection of the most suitable alloy for the purpose. It may be safely said that the aluminium alloys cover as wide a range and offer as varied physical characteristics as do the brasses, though, of course, having a field all their own on account of their lightness. But to the average user (and it is to be feared also to many founders) the chief requirement to be met is cleanness of finish in the casting and a good white colour; even lightness, the outstanding feature of the metal, is often overlooked, it being deemed that that quality is still retained if the metal is white.

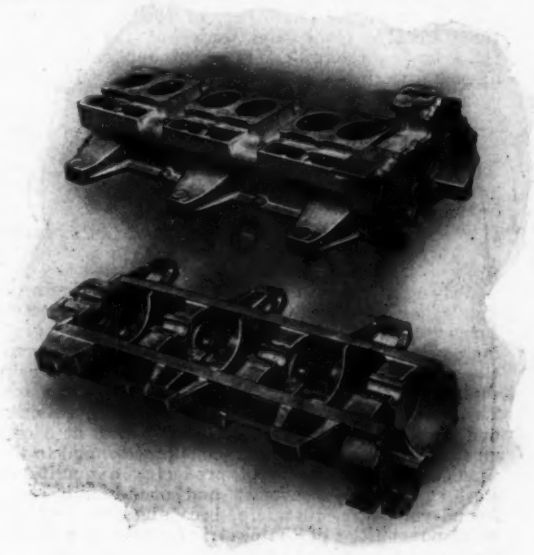
At times engineers complain that aluminium castings have not met the physical requirements that were expected of them, and hence these light alloys have been discarded. In all such cases the first question to be asked is as to what alloy was used; and in almost every instance the user will have no idea whether it was a mixture of Al. 50—Zn. 50 or Al. 90—Cu. 10, or any other, for that matter. Obviously such criticism of aluminium alloys without reference to the composition and the recognised physical properties of that composition is absurd—it is on a parallel with a drawn-brass worker complaining that 60-40 alloy containing lead will not draw properly. But the fact remains that users and founders alike have frequently much to learn regarding the distinctions between different aluminium alloys.

In the casting of aluminium there are no very great difficulties to be overcome, though some divergence of practice exists between the handling of aluminium and brass, and this fact is inclined to prejudice the orthodox brass-founder against the lighter metal. In the first place the choice of the alloy must be made intelligently, with a view to the requirements of the castings. Although practically all aluminium alloys are white there is as much difference between them as between copper and the brasses, and just as much depends upon the selection of the correct mixture. Having decided on the alloy (and for those who have not had experience with the requirements, standard casting alloys with specified properties are easily obtainable), it becomes necessary to follow the requirements of the metal through each department and process. In this connection the following notes, issued by the British Aluminium Company, will be useful.

Patterns.—The pattern-maker must bear in mind that aluminium shrinks some 13/64 in. per foot, and sufficient margin should be allowed on both patterns and core-boxes. Thin sections and complicated coring should be avoided wherever possible, for though the metal is very fluid when poured, it cools rapidly and is liable to set up shrinkage strains. For the same reason, ample fillets should be provided.

Moulding.—As regards moulding, for the best work green sand should be used, and the moulds be only lightly rammed. In making the cores, the sand is often mixed up with resin as a binder, which allows the core to soften and crush as the metal cools. Such cores must, of course, be knocked out hot, otherwise they will stick to the castings. Vertical risers and gates of ample size are essential to good work, particularly in view of the great shrinkage which has to be fed. Where possible a U- or siphon-shaped gate is preferable. A much better face is obtained on the castings if the moulds are faced with plumbago or French chalk.

Melting.—As in the case of brass, over-heating is very detrimental to the metal, though for aluminium the maximum temperature is much lower. It is therefore necessary to give great attention to this point, as aluminium is easily overheated, and if this takes place satisfactory castings are out of the question. The melting point is 1,210 deg. F. (655 deg. C.), and this should never be exceeded. A 500-lb. brass pot will take 140 lbs. of aluminium, and the metal should be added gradually as it melts down. Plumbago crucibles are advised wherever possible, though good melting has been done in a plain iron pot. The fuel most commonly used is coke, but high-pressure gas has been applied with marked economy and ease of working.



Example of Aluminium Casting for Motor-Car Work.

Pouring.—The pouring of the metal should be done at as low a temperature as possible if strong castings are desired. The metal is very fluid when molten, and is therefore easily poured. It should be cooled down to a dull red by adding a few small pieces of aluminium to the ladle and then be thoroughly stirred and skimmed, and poured in a steady stream, rapidly for green-sand and slowly for chill moulds. The moulds should be loosened as soon as possible after pouring. Owing to the cleanness of aluminium castings as they come from the mould, frequently it is found that little or no finishing is required. In any case, sand-blasting for large castings and dipping in soda and scratch-brushing small articles is generally sufficient.

Die-castings.—Aluminium alloys are now being extensively used for die-casting processes. The ease

with which repetition work can be turned out from permanent metal moulds, and the improved physical properties which are thereby attained are valuable features in favour of die-casting, and suitable alloys of aluminium have been proved to be excellent for this process, giving strong castings, having the cleanest finish possible to obtain.

Standard Alloys.—Reference has been made to standard alloys, and it is interesting to note here a few of the alloys obtainable and their characteristics. The following are standard alloys of the British Aluminium Company :—

No.	Specific gravity.	Tensile strength (tons per sq. in. (average) Sand mould.	Chill mould.
4	2.70	8	10
6	2.90	11	13
6a	3.10	13	16
6d	3.50	8	9

These alloys are designed for different applications. The first (No. 4) makes castings which are easily riveted, and is a good substitute for soft brass; the second (No. 6) gives very clean castings which are easily machined; the third (No. 6*a*) casts more easily than No. 6, is stronger but not so tough; while the fourth alloy (No. 6*d*) is suitable for small unimportant castings. There are, of course, other mixtures suitable for special work but the above are those having the widest range of application. For all-round work No. 6 is perhaps the best. It should be noted that the figures given above for tensile strength are average ones, and will, of course, vary according to the type of pattern being cast.

In choosing the alloy, the requirements of the casting, of course, must be carefully considered, as mentioned previously. It may be here remarked that since a given weight of aluminium will go more than three times as far as the same weight of brass or bronze, this fact has to be taken into account when making economic comparisons. At average market prices, the cost of metal to cast a given pattern can be reduced by nearly 50 per cent. if aluminium is used in preference to brass or bronze.

In conclusion, we may quote the following useful table showing the properties of metals for foundry work :—

Properties of Metals for Foundry Work.

	Aluminium.*	Brass. (66-34).	Bronze.	Iron.
Melting point °C. ..	625	1000	1060	1250
Melting point °F. ..	1160	1800	1900	2280
Shrinkage per cent. ..	1.7	1.4	1.4	0.8
Specific gravity ..	2.9	8.4	8.5	7.2
Weight lbs. per cu. ft.	160	525	530	450
Weight lbs. per cu. in.	0.093	0.304	0.307	0.260
Relative weight to cast a given pattern ..	1	3.3	3.3	2.8
Average tensile strength (tons)..	11	13	15	7.5

* The No. 6 alloy quoted in previous table.

From this table an interesting comparison may be made between the metals named.

The Electric Steel Furnace in Foundry Practice.

Writing in "Metallurgical and Chemical Engineering," Paul Girod, the inventor of the Girod electric furnace, remarks that the electric steel furnace is increasingly extending its influence in foundry practice as an aid to the open-hearth furnace and as a sharp competitor to the crucible or small converter. This evolution, he contends, is due to the possibility and ease of producing a high-quality steel at a cost much lower than with the crucible process, and to the simultaneous advantage of producing a quality of steel superior to converter and open-hearth steel. Foundrymen are, therefore, becoming aware of the great possibilities of the electric furnace as a simple apparatus for making best-quality steel castings.

The electric steel furnace is especially well-suited for castings, since it offers the possibility of holding finished steel in the furnace as in a mixer, and to tap it at intervals as desired into small ladles. Different taps can be made at different temperatures, lower temperatures being used for larger moulds and higher ones for small castings. The steel can be heated to any desired temperature and castings can be made very thin-walled and of a very small size. Pieces from ½ lb. and upward with sections of 5 to 7 mm. thickness can be cast without any difficulty. With the electric furnace one is sure to have for castings an absolutely dense steel without blowholes and pipes.

Recently a very important improvement has been realised by introducing into electric steel practice for castings the use of special titanium alloys such as manufactured by the Société Anonyme Electrométallurgique Procédés Paul Girod, of Ugine (Savoie), France, of approximately the following compositions :—(1) Si. 56 per cent., Ti. 36 per cent.; (2) Si. 21 per cent., Ti. 28 per cent.; (3) Si. 10 per cent., Ti. 10 per cent

Even very small additions of these alloys render the steel perfectly quiet, and insure the castings becoming very dense and free from any blowholes. The number of lost heats can be very much diminished. Microscopic examination of electric steel made with the aid of titanium alloys shows the perfect density of the steel and the absence of any traces of oxides or blowholes.

After dealing with the construction of the Girod electric furnace, which has previously been described and illustrated in our columns, M. Girod proceeded as follows :—

The Refining Process.

The Girod furnace is suitable for the melting and refining of ordinary scrap or steel waste of every composition. The addition of pig-iron to the charge is not necessary, and its use in small proportions offers advantages only in the case of highly oxidised raw material. The operations can be divided into two periods :—(1) Oxidation period; (2) deoxidation period.

First Period.—An oxidising slag is formed by adding to the charge some lime and iron ore. The proportion of these additions varies according to the chemical purity of the charge, and is determined in such a way that when the melting is completed the bath contains less than 0.1 per cent. C., Mn., and Si. In this period of refining the oxidation takes place vigorously and the original low temperature of the bath favours the elimination of the phosphorus. Practically all phosphorus is removed before slagging.

A forging test will easily show whether the metal is in the extra-soft state. In this case as soon as the temperature of the bath has become sufficiently high the slag containing phosphorus and iron oxides

is tapped off through the charging door by tilting the furnace slightly backward. The first slag is immediately replaced by some lime which cleans the last traces of phosphoric slag from the bath. One slag is generally sufficient to remove all phosphorus down to traces.

Second Period.—The oxidising and cleaning slag being removed, a first deoxidation of the bath is effected by adding deoxidising agents, such as ferro-silicon, ferro-manganese, etc., these alloys being added in such proportion as not to remain in the bath. At that time recarburisation takes place if hard steel is to be made.

Then the bath is rapidly covered with a slag consisting of about five-sevenths of lime, one-seventh of silica sand, and one-seventh of fluorspar, together with a slight addition of carbon in the form of petroleum coke. In this second period of deoxidation care must be taken that the furnace be properly closed, the temperature being held sufficiently high so that the iron oxide in the slag is reduced. The destruction of the ferrous oxide in the slag is indispensable for the deoxidation and desulphurisation of the bath. It is gradually reduced by deoxidisers such as ferro-silicon and the addition of some petroleum coke to assure complete deoxidation, and a slag is obtained which, in the air, disintegrates into a white powder, the ferrous oxide being reduced down to traces.

In order to hasten the complete deoxidation of the bath it is useful to add small quantities of silico-manganese, or ferro-silico-manganese-aluminium, or even silicon-aluminium, these alloys acting very energetically upon the oxides of the bath, forming a very fluid slag which easily rises to the surface.

During the same period, when the slag is completely deoxidised and is very basic, the desulphurisation which was incomplete during the first stage of the operation proceeds further, and is rapidly completed at the time of tapping. Desulphurisation starts vigorously when the highly basic lime slag becomes white and readily fluid, *i.e.*, after the removal of the metallic oxides. Carburising materials are eventually added for finishing the metal ,and the final addition of ferro-silicon, ferro-manganese, etc., is made in order to arrive at the required composition of the steel.

The average analysis of the final white slag is as follows :—CaO, 74.85 per cent.; SiO_2, 13.20 per cent.; FeO, 0.13 per cent.; MnO, traces; S, 1.2 per cent.; Fe_2O_3, none; Al_2O_3, 1.75 per cent.; MgO, 4.22 per cent.; P_2O_5, 0.09 per cent.

Cost of Refining Cold Charges.

The power consumption recorded at the terminals of the furnace and including smelting, refining, and finishing a charge of cold scrap is about 850 kw.-hours per ton of metal tapped for a 3-ton furnace, and 750 kw.-hours per ton of metal tapped for a 10-ton furnace. Of course, these figures vary with the composition of the charge. According to the quality of the steel and its purity, the figures may be higher or lower.

The consumption of electrodes per ton of steel made is about 8 to 9 kilograms for a 3-ton furnace, and 8 to 10 kilograms for a 10-ton furnace. These figures indicate the consumption of electrodes of good quality, and may be considerably reduced by the latest improvements introduced in the manufacture of the electrodes which permit them to be completely used up.

As to wages, the furnace needs :—One smelter, one second hand, and one boy for the 3-ton furnace; one smelter, two second hands, and one boy for the 10-ton furnace.

The furnace can be lined with magnesite bricks or better tamped with tarred magnesite or dolomite. Dolomite-tamped bottoms are giving the best results. The work is done with heated hand tampers or with pneumatic rammers. The life of the lining is about 90 to 100 heats for a furnace of 10 tons and about 120 heats for the 3-ton furnace. At the end of that time the side walls and the hearth will need repairing. All the burned or oxidised parts of the walls are scraped. The bottom is broken down about 10 to 15 cm. and is retamped with new layer of dolomite, taking care to leave intact the passage of the tops of the bottom electrodes. This repair of the upper part of the bottom is the only one required, the damage of the walls at the slag line being repaired between charges with dolomite. The roof of the furnace is made of silica brick and stands on an average 50 heats for the 10-ton furnace and 70 heats for the 3-ton frunace.

The cost of the additions, *i.e.*, lime, ore, silica, sand, fluorspar, and petroleum coke, to mave the slag, and ferro-alloys for deoxidation and finishing, varies considerably with the purity of the raw material used and the quality of steel.

As to heating losses, the output is about 90 to 96 per cent. of the charge; it depends much on the degree of the oxidation of the scrap.

Cost of Refining Liquid Charges.

With liquid charges, on the other hand, where the working period for a heat is only 2 to 2½ hours, the cost of electric steel refining is considerably reduced and allows a reduction of more than 25 per cent. on the cost price according to the local conditions. On the lines of these conditions and indications the following estimate for the cost per ton of steel tapped with the Girod system is arrived at:—

COLD CHARGES.

Raw Material :	3-ton. £ s. d.	10-ton furnace. £ s. d.
Scrap, 1 10 tons at £3 per ton	3 6 0	3 6 0
Slag	0 1 9	0 1 9
Deoxidizing additions and recarburisation..	0 2 9	0 2 9
	3 10 6	3 10 6
Producing Cost :		
Electric power, 850 and 750 kw-hours	0 13 6	0 12 0
Electrodes..	0 2 4	0 2 9
Wages	0 2 4	0 1 2
Maintaining and repairs..	0 9 6	0 6 4
	1 7 8	1 2 3
Total cost per ton	4 18 2	4 12 9

MOLTEN CHARGES.

Raw Material .	3-ton. £ s. d.	10-ton furnace £ s. d.
Liquid steel 4 per cent. loss in heating, 1.04 tons at £3 4s. per ton ..	3 6 6	3 6 6
Slags	0 1 7	0 1 7
Deoxidising additions	0 2 9	0 2 9
	3 10 10	3 10 10
Cost of Producing :		
Electric power, 275 and 200 kw-hours	0 4 4	0 3 2
Electrodes	0 1 2	0 1 2
Wages, 8 heats in 24 hours	0 0 10	0 0 10
Maintenance and repairs of the furnace	0 3 2	0 2 0
	0 9 6	0 7 2
Total cost per ton of steel ..	4 0 4	3 18 0

The estimate does not include the expenses for ingot moulds, superintendence, laboratory, amortisation, and general charges, which vary so considerably as not to allow a fair average estimate.

Recent Developments in Open-Hearth Steel Practice.*

By N. E. Maccallum.

As furnaces began to grow in number and in size, a question arose to which no satisfactory answer has ever been given, and that was: "What is the safe and economical limit of the open-hearth furnace?" Various stopping places have been suggested, and 20, 30, 40, and 50 tons have each been advocated, but all such arbitrary restrictions have been passed, and 60 tons would probably represent the average furnace, although in a few instances from 70 to 80 tons are regularly tapped into one ladle. The furnaces which are the subject of the present Paper have gone far beyond even these limits. They are the property of the Phœnix Iron Company, of Phœnixville, Pa.,

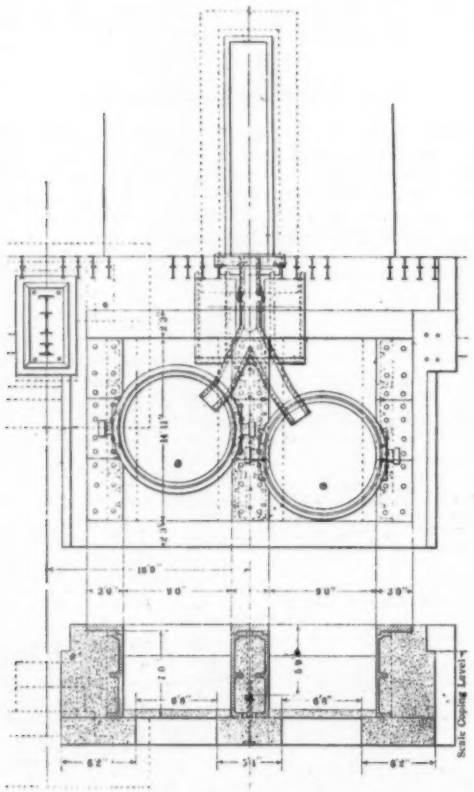


FIG. 1.—PLAN OF TWIN LADLE PIT AND SPOUT FOR OPEN-HEARTH FURNACES.

and their distinctive and important feature is that they charge to twice the capacity of one ladle, and tap simultaneously into two ladles, with a device for controlling the flow into either. In this way the capacity of the furnace is not limited, as formerly, but heats of any size within the capacity of two ladles may be charged. The ultimate reason for charging furnaces beyond the normal amount is not that large heats may be made, but because by making large heats a material increase of product is obtained.

A plan of the divided spout, pits, and ladles is given in Fig. 1. In order to make the branches of the spout as short as possible, one ladle is placed slightly in advance of the other, which also enables the trunnions to clear. Fig. 2 shows a plan and a front elevation, and Fig. 3 a side elevation, of the device for controlling the flow of steel into either ladle. Its purpose is not to stop, but merely to check, the flow. The levers by which it is operated are placed from 20 to 30 ft. from the centre of the furnace, and the controlling rod is protected by fire-brick, much the same as the ladle rod.

The first of these furnaces, here designated as A, B, and C, was completed early in 1909. The area of the hearth, which had been decided upon after a few friendly visits to neighbouring plants, was 32 by 14 ft., and was a fair average of furnaces charging from 50 to 55 tons of materials. At that time no thought had been entertained of breaking away from the established practice, but on comparing the capacity of this hearth with those of our smaller furnaces, it proved to be so much in excess that the question was raised as to the advantage of a large hearth if it could not be fully utilised. Various experiments were then undertaken to determine the feasibility of using two ladles, and the best means of controlling the flow into either ladle, which resulted in our present practice.

Furnace B, completed in September, 1909, was the same in all respects as Furnace A, except that the hearth was lengthened 4 ft., making it 36 by 14 ft. in area.

Furnace C was built in 1911, the size of the hearth being increased to 42 by 15 ft. The size of the regenerator chambers was also increased. These chambers were designed to meet existing conditions. The air-chambers of Furnaces A and B are 9 ft. wide and the gas chambers 6 ft. wide. For Furnace C the air chambers are 12 ft. wide and the gas chambers 8 ft. wide. The length of chambers and depth of chequer work are uniform for all the furnaces, 18 and 7 ft. respectively. If now these furnaces are rated as 115 tons, 130 tons, and 165 tons capacity, which is the usual weight of ingots tapped from each, it will be noted that the chequer space on each end of the furnace is only equal to about 15 cub. ft. per ton of hearth capacity; or one-sixth of the amount generally allowed and recommended by prominent metallurgists. This statement is not made from any desire to criticise or detract from the prevailing views and practice; but it might be worth while to note that, had this practice been followed, the depth of chequer-space in Furnaces A, B, and C would have been 46 ft. instead of 7 ft. Or, to state the same thing in another way, the rated capacity of the furnaces, based on chequer-space, would be 19 tons for Furnaces A and B and 25 tons for Furnace C, instead of 115, 130, and 165 tons. It may therefore be safely assumed that any particular merit

* Abstract of Paper read at the Cleveland Meeting of the American Institute of Mining Engineers, and printed in the "Transactions" of the Institute.

which this practice possesses must be attributed to causes other than the chambers.

The areas of the hearths of Furnaces A and B were practically the same as those of ordinary furnaces rated at from 50 to 55 tons capacity, and that of Furnace C, 42 by 15 ft., giving an area of 630 sq. ft., is almost an exact duplicate of the area of a number of furnaces recently completed and rated at 60 tons. The hearths are of the usual depth, and measure from pan-plate to top of fore-plate 5 ft. 0.5 in. The pan is covered with 18 in. of brick and from 10 to 12 in. of magnesite in front of tap-hole. If, therefore, the hearths are of the same size, and the chambers are much smaller than those of many other furnaces, it is apparent that the large tonnage must be due to other reasons, which we shall endeavour to show lie not in the furnace, but in the practice.

to hearth or otherwise and show a decreased tonnage, although it might be a faster working furnace. For a number of years I have used, as a basis of comparison, the time from beginning the charging until the tap-hole is open, divided by the product, which gives, in minutes per ton, the rate at which steel is being made. This gives a reliable means of determining the speed with which any furnace is capable of making steel, and also its ability to compete with other furnaces. Using this method of comparison, Table I. has been compiled from furnace records. In every case the record covers a period of not less than six months, and should be fairly representative of the work done by each furnace. The smaller furnaces are of the older type with regenerators underneath the hearth, but did efficient work and compared well with other furnaces of similar construction. Furnace C now stands on the site formerly

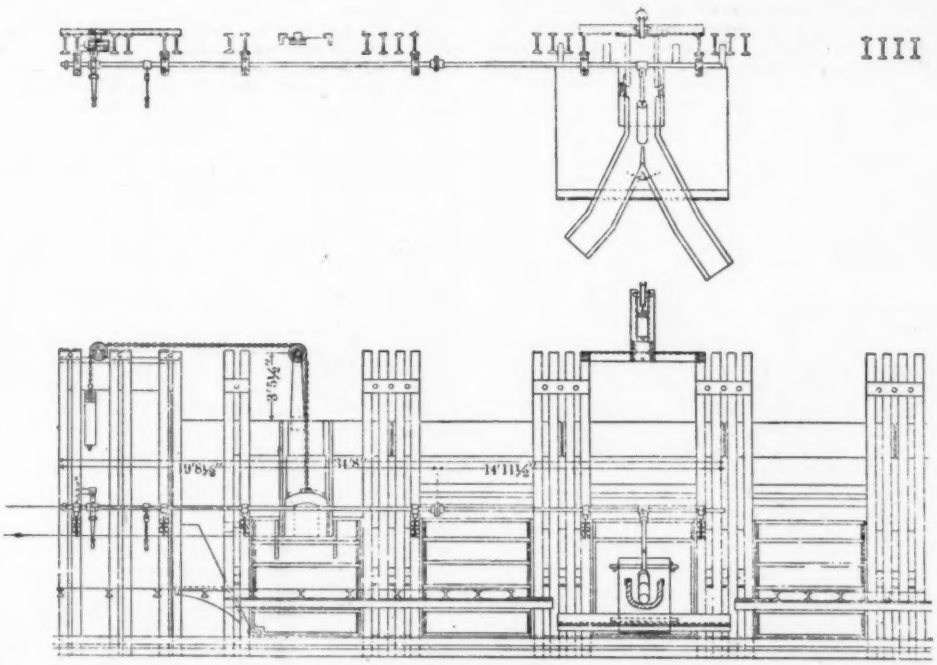


FIG. 2.—PLAN OF STREAM CONTROLLER FOR TWIN RUNNER SPOUT, AND FRONT ELEVATION OF OPEN-HEARTH FURNACE.

On one occasion, in discussing methods of operation with the superintendent of a large steel concern, I asked if he reduced the size of open-hearth heats at the week-end, and the reply was that he did not, as it had been found that a large heat could be made almost as quickly as a small one. That was the open-hearth man's way of broadly stating a truth which was not intended to be accepted too literally. It is not true, of course, that a large heat can be made as quickly as a small heat, but it is true that steel is made faster in a large unit than in a small one. This seems an obvious fact, yet it is one that receives but little attention and is rarely considered in comparing the work of one furnace with another. In most works, the number of heats which each furnace makes weekly constitutes the basis of comparison; but it is evident that for furnaces of different capacities it would be of little value, since the small furnace might make more heats and yet not equal the tonnage of a larger furnace, or, in furnaces of similar capacities, one might be delayed with repairs occupied by two of the smaller furnaces, Nos. 5 and 6, and it is interesting to note that Furnace C is making steel just a little more than three times as fast as No. 5 formerly did.

TABLE I.—*Data of Furnace-Practice.*

Furnace.	Hearth-area.	Weight of ingots.	Time per ton.
		Tons.	Minutes
No. 3 ..	17.5 by 12 ft.	30	32.79
No. 5 ..	20 ft. 3.5 in. by 12.5 ft.	40	26.48
No. 1 ..	24 ft. by 12.5 ft.	50	19.66
A. ..	32 by 14 ft.	115	11.50
B. ..	36 by 14 ft.	130	10.50
C. ..	42 by 15 ft.	165	8.68

A study of Table I. will reveal two significant facts: One, that the economical limit, so far at least as time is concerned, has not been passed, since Furnace C is shown to be making steel 21 per cent. faster than Furnace B. The other, the striking de

crease in minutes per ton as the hearth area and unit of steel increase, and it is on this fact that the practice of the Phœnix Iron Company is based. The extent to which any furnace may add to its product will be proportional to the excess charged over the normal one-ladle heat, but from the experience of the Phœnix Iron Company, it may be affirmed that by doubling the normal charge the product of any furnace can be increased by from one-fourth to one-third; that is, if a furnace charging single-ladle heats can produce, say, 600 tons weekly, it will by charging double-ladle heats produce from 750 to 800 tons. This can be readily demonstrated by operating any furnace alternately on single-ladle heats and half-ladle heats, and comparing the number of minutes required in each case to make a ton of steel.

Why should steel be made faster in large units than in small? No particular reason can be assigned, but there are several probable causes which contribute to that result. The first and most important is the economy in time; that is, in a given time more steel will be produced, or the same amount of steel will

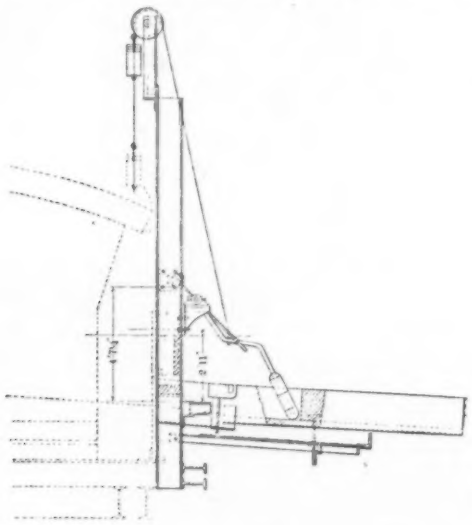


FIG. 3.—SIDE ELEVATION OF STREAM CONTROLLER

be produced in less time. This can be better understood by dividing into two periods the time required to make a heat of steel, the first period being the time required to charge and melt, and the second period the time from when the lime floats to the surface of the bath until the heat is ready to be tapped, known as the "working" of the heat. In the first period the double-ladle heat will not show much gain over the single-ladle heat, as it will take almost twice as long to charge and melt, but in the second period, when spar, ore, and other additions are made, the double-ladle heat gains a decided advantage, since it takes but little longer to "work" a large heat than a small one. At various times during the past three years single-ladle heats have occasionally been made on Furnaces A, B, and C, and a careful scrutiny of the records shows that the average time required to make a ton of steel on those heats was 12.2 min., while the average time at which furnaces were running on double-ladle heats was 9.7 min., showing that it required 25.7 per cent. more time to make a ton of steel on a single-ladle heat than on a double-ladle heat.

As a second cause, it is evident that twice as many single-ladle heats will be required to produce the same tonnage as that from double-ladle heats, therefore one-half the time which would be required to make repairs to the hearth in the former case will be available for making steel in the latter. Then again, each heat of steel that is made, whether large or small, entails two extremes of temperature, viz., the cooling of the hearth and furnace when cold stock is introduced, and the maximum temperature necessary to tap, at which time the hearth and furnace must be raised to at least the same temperature as the steel. It will therefore take twice as many heat units to raise the furnace and hearth to this temperature to make two single-ladle heats as would be required to make one double-ladle heat, just as in heating water or other substance in a refractory vessel, less time will be required to heat a certain amount in one portion than to divide that amount into two portions and heat each separately, the difference in time being that required to heat the container a second time.

A third cause is radiation. Campbell,* in reference to heat distribution in an open-hearth furnace, says: "Roughly speaking, about one-half of all the heat supplied to an open-hearth furnace is lost by radiation and conduction." That statement concerns the present Paper only to the extent that the more frequently a furnace is raised to a tapping temperature the greater will be the loss by radiation, as the latter increases with each degree of rise of temperature, so that the fewer heats that are made in proportion to the tonnage, the less frequently will the furnace be raised to a tapping temperature, and the less will be the loss by radiation. This is simply illustrated by noting the time required to heat a volume of water from t° to the boiling point, then removing a portion and replacing with water at t°, and again raising to the boiling point, and repeating the operation until the added portions equal the original volume. The added portions collectively will take longer to boil than the original amount, the difference being equal to the excess radiation that has occurred at the higher average temperature.

These views have been advanced with some hesitancy, but they appear to offer a reasonable explanation why steel is made faster in large units than in small ones. To confirm these arguments further, a statement of the actual tonnage which each furnace has made is given below. All the stock is charged cold, and the fuel used is producer gas.

Furnace.	Period of time.	Output.	Time per ton of output.	Fastest time for one ton of output.	Largest heat.
		Tons.	Minutes.	Minutes.	Tons.
A ..	First year ..	41,436	11.45	8.27	130.04
	Second year ..	39,910	11.54		
B ..	First year ..	43,900	10.38		
	Second year ..	43,615	10.44	7.49	146.32
C ..	47 weeks ..	47,200	8.68	6.92	177.77

Furnace C has still five weeks in which to complete the year and should run well over 50,000 tons, which is probably the largest tonnage ever produced from any furnace using all cold raw material.

The saving in cost, which will be proportionately increased as the tonnage increases, depends upon labour, fuel, and repairs.

The number of men necessary to operate a furnace on a double-ladle heat is the same as on a single-ladle heat, and if the product is increased one-third, it is

* "Manufacture and Properties of Iron and Steel," 3rd ed., (1904)

apparent that the labour will be reduced one-fourth, including all furnace labour except that of the stock loaders.

The fuel (gas coal), covering a period of several months, will not vary much whether the furnace is making large or small heats, and, as is the case with the labour, should show a saving of one-fourth. Furnaces A and B are on the same gas-line as the blooming-mill soaking pits, and consequently it is difficult to get accurate data. Furnace C, however, is supplied from an independent line, and the figures used are based on the actual amount of coal received in the cars. On a run of 22 consecutive weeks, including the entire time from commencing the first heat until shut down for repairs, the average amount of coal used per ton of steel was 547 lbs. Just whether this represents a saving of one-fourth is uncertain, but we can estimate what the amount of coal would have been had the furnace been operated on single-ladle heats, in which case the product would have been reduced one-fourth and the amount of coal increased one-third. Furnace C averages slightly more than 1,000 tons of product weekly, so the product would have been 750 tons, and the coal increased one-third would have been 729 lbs. per ton of steel. That is, instead of 1,000 tons of steel with a coal consumption of 547 lbs., on double-ladle heats, we should have 750 tons of steel, with coal consumption of 729 lbs., on single-ladle heats.

Bearing in mind the arguments that were advanced in explanation of the increased product of large heats, the use of pig-iron with an average contept of 0.70 phosphorus and 0.70 silicon, with considerable quantities of lower-grade iron as cheapeners, together with the miscellaneous scrap that the market affords, 729 lbs. of coal cannot be considered excessive for Eastern practice, particularly covering a period of 22 weeks, so that it is probable a saving of one-fourth is not far wide of the mark. With larger regenerators it is likely a still further saving might be effected.

What has been said in regard to labour and fuel should also apply to repairs. That is, in a given period the wear and tear will be about the same, regardless of the size of the heat or of product. In the run of 22 weeks, the total product from Furnace C was 24,298 tons, and the repairs that followed, including roof, linings, chequers, cost of brick, bricklaying, and common labour, was a fraction less than 6d. per ton.

Having discussed the increased product and economies resulting from the two-ladle practice, what are the objections likely to be raised against this method of steel-making? Probably the first would be the risk of handling such large quantities of steel and the possible consequences in case of accident. In reply, it may be said that in modern open-hearth practice, when linings have been increased in thickness, partly to overcome excessive radiation and partly to prevent accidents, break-outs rarely occur, and as double-ladle practice requires only one-half the usual number of heats to produce the same tonnage, it is evident that that risk, whatever it is, has been cut in half. It may be imagined that serious trouble might result from the chilling of a heat in the furnace, as occasionally happens when the roof falls in. I confess that the first instance of this kind was viewed with some apprehension. It occurred on Furnace B, when a charge of 385,000 lbs. was melted; the roof from hip to hip fell in. This happened at 8 a.m. on a Saturday, and during the next day the roof and lining were replaced. Gas was turned in at 5.30 a.m. Monday, and the heat was tapped at 10 p.m. Tuesday, yielding 139 tons of ingots. A similar experience occurred another time, but in neither case were any difficulties presented other than would be encountered in smaller heats.

Absorption Alloying.

By Walter J. May.

Although not directly affecting the foundryman so far as immediate mechanical effects on plant are concerned, the power of metals to absorb other metals at times proves inconvenient in the foundry when alloys of a certain content have to be made, and more particularly when prices are cut down to the lowest point, so that scrap metal has to be used to some extent. Iron is cheap enough as a rule to permit of the use of new metal where special castings are needed. It is with copper, bronze, and brass that the founder is more particularly concerned, as these are high-priced metals, and in most cases can be taken for further use, or as the foundation of other alloys provided they contain nothing objectionable. Without a full analysis, however, a lot of these scrap metals are not good enough for particular work. For instance, copper fireboxes are esteemed to be good metal for making brass and bronze, and no doubt they are in many cases, but in others they will have absorbed both sulphur and arsenic from the fuel to some part of their thickness, and neither of these are desirable. Brass boiler tubes also absorb gasified substances from the fuel, and although in many cases they could not be excelled by new metal, in others they would lead to bad failures under test. In some kinds of chemical work, also, metals absorb some of the content of the materials with which they are in contact; and these, to say the least, are not always desirable of the future working of the metal.

Besides absorption from gasified matters, metals will often absorb metals with which they are in contact, copper readily absorbing tin, and iron or steel absorbing silver, as in pyro-plating on these metals. Necessarily, heat has to do rather largely with this form of absorption, while in some cases on being melted the absorbed metals will be volatilised, although this is not always a certainty, for, while some metals volatilise at less than the melting points of others, it does not follow that when they are combined separation will take place. Thus brass melts at 1,600 degrees Fahr. or over, but zinc distils off at below 1,000 degrees Fahr., yet with careful melting very little zinc is lost from the brass in ordinary melting, although with a very high temperature over and above that needed for melting, the zinc will, with part of the copper, be burnt out. The same thing happens with the other metals, and whether purposely or accidently present it is a difficult matter to remove them in ordinary foundry practice.

In some cases from 1 per cent. to 2.5 per cent. of foreign matter has been found in copper which has been badly dealt with, hence the necessity of care in using scrap metals in making alloys which have to go under either analysis or mechanical tests.

The mere fact that alloying may be done by absorption is put to practical use in case-hardening where, at certain crucial temperatures, carbon is absorbed by the iron or mild steel. In the same way copper will absorb tin if it is rubbed over the copper while this is at a bright red heat, and while soldering bits are injured by this practice it is quite easy to make the surface alloying and hardening a matter of commercial value. This, however, does not affect the foundry.

Owing to a mistake on the part of the authorities the name of the Selson Engineering Company, Limited, 85, Queen Victoria Street and Lambeth Hill, London, E.C., has been omitted from the telephone directory. We understand, however, that the numbers are as before—Bank 341, and Central 11,779.

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The Chemist as an Adjunct to the Foundry.

By F. H. Hurren.

One of the most vexed questions of recent years in foundry circles is the utility or otherwise of scientific control in the foundry. It is not always possible for a firm to establish a properly equipped laboratory and maintain a trained chemist, but there is always the alternative of having the work done by contract with an independent chemist. To engage other than a trained man is worse than useless; in fact, money so spent might just as well be thrown away. On the other hand, no self-respecting chemist can reasonably be expected to work in an imperfectly equipped laboratory. The writer has known of firms going to considerable expense in fitting up a laboratory, and then expecting to retain the services of a first-class man for about £80 per annum. On the other hand, a firm will engage a good man and then begrudge the expense of proper equipment. Unless a firm is sufficiently wealthy to stand the cost of fitting out a laboratory, the best course is to have their work done by an outside chemist. Those who can afford it, and get an up-to-date man, will find him a good investment.

A laboratory of sufficient size to accommodate a chief chemist and two assistants, can be satisfactorily fitted out for about £200; and the cost of upkeep for chemicals and replacements should not exceed £40 per annum. The chief item of expense is, of course, in salaries, but one has to remember that in one day a chemist may save his firm sufficient to pay his salary for many months.

Much of the prejudice against the chemist has arisen owing to his ignorance of foundry practice. Until chemists realise this, and aim at obtaining an insight into foundry problems from a more practical standpoint, the profession will always stand in an uncertain light. Fortunately this is being recognised.

The writer knows of a chemist who had never been inside a foundry in his life, but who sent in a learned but useless report on the mixing of certain irons, and then wondered why more work from that firm did not come his way. Often, however, the chemist is not fairly treated. He is considered a tame magician, who has only to dip iron in certain liquids, and can tell at once what brand, or mixture of brands, it is. In one case a chemist was given a piece of iron casting, with a request to know what was the matter with it. When he naturally enquired in what way it failed to give satisfaction, the would-be client assumed an injured air, and thought the chemist could find that out by analysis. His opinion of chemistry went down to zero To obtain the best from a chemist, he should be made aware of all details as to intended composition, method of casting, the use to which the article had been put, and the extent to which it failed. From his analysis, on microscopical examination, and a practical knowledge of the processes involved in manufacture, he should be able to deduce reasons for failure. Of course, it is not always possible to give exact cause of failure, and in these cases, a practical chemist often may make suggestions as to modified methods of manufacture. This is where the chemist with foundry experience scores.

There must be perfect candour and faith between chemist and foundry foreman. To make for the most good for the firm they work for, they must be able to discuss difficulties amicably. Nothing promotes good results so much as absolute openness between these two men, and it is well for them to get together frequently, to talk matters over. Unless the foreman has a theoretical knowledge of metallurgy, the chemist must translate his results into simple language, as the average foreman looks with suspicion on the (to him) unintelligible jargon of chemistry. It is quite useless to explain to him that a certain sample of iron, when viewed under the microscope, showed a structure composed of areas of cementite surrounding segregations of phosphide eutectic. He may look impressed, but secretly feels sorry for the chemist.

The foreman has many opportunities of throwing dust in the eyes of the chemist, and will not hesitate to use them if the latter upsets him. If, however, he can see that the chemist is something more than a mere analytical machine, with less productive capacity than a moulding machine, he will gladly take him into his confidence, to their joint benefit. The writer has known a chemist to instruct the furnaceman to make certain alterations in the mixtures, without first consulting the foreman. This is not playing the game, and foremen naturally resent it.

As an example of a chemist failing through lack of foundry knowledge, may be quoted the case of a chemist who was asked for an iron mixture which was required to be of close grain, not to exceed 0.6 per cent. combined carbon, nor 0.7 per cent. phosphorus. Of the irons at his disposal he chose two which may be called Nos. 1 and 2; and gave as the mixture to be used, four parts of No. 1 to one part of No. 2. Included in his report was the analysis of the two irons, and an estimated analysis of the mixture. These are given in the table, and in the last column is the actual analysis of the mixture as cast :—

	No. 1.	No. 2.	Estimated analysis.	Actual analysis.
	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon ..	0.55	0.50	0.54	0.75
Graph. carbon ..	2.36	2.68	2.42	2.19
Silicon	2.60	2.84	2.64	2.63
Sulphur	0.08	0.02	0.07	0.10
Phosphorus	0.30	1.24	0.49	0.51
Manganese	0.68	1.10	0.76	0.53

The chemist took no heed of the influence of remelting, and instead of getting 0.54 per cent. combined carbon, he actually obtained 0.75 per cent. In consequence, the castings were rejected owing to difficulties in machining. The foreman had, on the particular day this iron was used, to ensure hot iron, worked his cupola with a little extra coke. The castings had been poured a little hotter than they need have been, causing the retention of combined carbon, due to rapid cooling in the mould.

There may now be indicated some of the many ways in which a properly trained chemist can direct his energies, to the enhancement of his own reputation, and the pecuniary benefit of his employers. These must not, however, be considered as the only avenues of usefulness.

Many foundries use gun-metal scrap, purchasing what is known as Admiralty scrap. From the analysis of many tons of this class of material, the

writer has found the tin content to average about 10.5 per cent. Unless a casting specially calls for this quantity of tin, it is policy, as well as economy, to reduce it somewhat. In one instance experienced by the writer, castings which were being made from this mixture answered equally as well in a cheaper mixture. The analysis of the castings was approximated as follows:—Copper, 84.9 per cent.; tin, 10.8 per cent.; zinc, 4.2 per cent. Sample castings were made, using 75 lbs. of this mixture, with 25 lbs. of an alloy of copper 70, zinc 30. The resulting alloy approximated:—Copper, 81.5 per cent.; tin, 8.5 per cent.; zinc, 11.0 per cent. At the then current prices of copper £80 per ton, tin £215 per ton, and spelter £28 per ton, the second mixture showed a saving over the first of 6s. 6d. per cwt. This, on an average output of 2 tons per week, meant a saving of about £670 per annum. Another firm were making gun-metal castings from copper 86 per cent., tin 8 per cent., and zinc 6 per cent., and were having trouble with porous castings. Their chemist recommended a mixture of copper 83 per cent., tin 3 per cent., and zinc 14 per cent., and made suggestions as to method of melting and rapid cooling when cast. The results were successful, and the metal alone was 10s. per cwt. cheaper. With the price of tin so high, chemists might turn their attention to finding a substitute for tin in bronze castings. Manganese has big possibilities, and is easily obtained. Manganese-brass can often be substituted for gun-metal, and so far only the fringe of possibilities in this direction has been touched.

In one case aluminium castings were being made in which a large flat surface was to be machined all over. The machine shop complained that the metal was inclined to drag on the tool, preventing a perfect finish. The metal analysed out at aluminium 90 per cent., copper 4 per cent., and zinc 6 per cent. By increasing the zinc and decreasing the other constituents, an alloy was obtained which answered the requirements. The analysis of this alloy was aluminium 87 per cent., copper 2.5 per cent., zinc 10.5 per cent. Taking the price of aluminium at £80 per ton, and copper and zinc as before, this second alloy was 2s. per cwt. cheaper than the first. On an average output of 6 tons per week, this means a saving of £600 per annum.

In an ironfoundry one of the chief duties of a chemist is to check by analysis the pig-iron as delivered. Mistakes are apt to occur even with the most popular brands. In a certain foundry one particular brand was used for a job, in which it was important that the silicon should not exceed 2.5 per cent. Month after month, deliveries were checked and the iron agreed to specification, until one delivery gave 3.6 per cent. silicon. Repeat analyses were made on different samples; the silicon content averaged 3.4 per cent. The iron was rejected by the chemist, and the makers, when communicated with and supplied with samples, admitted a mistake. Had this lot of iron been used in the foundry, untold trouble and expense would have been caused.

The chemist's duties will also include devising mixtures of irons from the brands available, also determining the proportion of scrap each brand or mixture will carry. In making his mixtures he must have due regard for the changes taking place in remelting, and the peculiarities of the cupola. He will also take periodical analyses of the coke, with a view to avoiding excessive sulphur or ash; as well as check the castings by tensile tests and microscopical examination.

In malleable foundries, the chemist must concern himself with the processes involved in annealing, taking frequent samples from different places in the ovens, for chemical, mechanical and microscopical testing. He must also analyse batches of coal, coke and annealing ore as delivered. Time can profitably be spent in studying the effect of various mixtures of white iron, with particular reference to shrinkage.

In brass and aluminium foundries, in addition to the previously-mentioned points, may be mentioned the analysis of raw materials as delivered, and the frequent analysis, tensile testing, and microscopical examination of castings. This latter is a great aid in discovering if the metal is being properly melted and alloyed. The microscope also helps in determining whether castings are being poured with metal at the right heat.

Good work can be done by determining the loss of zinc in making up alloys and during remelting; and the chemist should do his best to reduce this loss by instilling scientific methods of melting into the furnaceman. The loss of zinc has been described variously, from 5 per cent. to 40 per cent., and it is high time that the foundryman had some definite data to calculate on.

Much good may be done by a chemist, but only provided he has (and merits) the confidence of his employers in general, and the foundry foreman in particular.

The writer believes it will be only a matter of a few years before every foundry will be controlled to a certain extent by a chemist, who will be a necessity rather than a luxury. To attain this end the chemist must free himself from much of the dogma with which he is at present saturated, and be able to discuss foundry problems in a broader spirit. This is not, in any way, disparaging the work done by the non-scientific man, but as engineering demands call for more and more vigorous tests, so the foundry must keep pace by the aid of science to satisfy these demands.

Melting Aluminium Chips.

According to an article in "Métaux et alliages," in melting aluminium chips or those of light alloys, and especially when in very small fragments (turnings, filings, etc.), there is only about 30 per cent. of metal melted. It was discovered that by adding a small quantity of anhydrous $AlCl_3$, 50-60 per cent. of the chips was melted instead of 30 per cent. By two or three operations of this kind it is possible to melt 70 per cent.

A Zinc Bronze.

As a result of a series of experiments, the foundry laboratory of Escher Wyss & Company, Zürich, Switzerland, produced a zinc bronze, of simple composition but possessing high breaking strength and tenacity. Tests carried out during the last three years have shown this material particularly suitable for the construction of runners and impellers of pumps and turbines exposed to the wear and tear of high-speed water or impure liquid or acids. At the engineering works of the firm and also at Ravensburg (Würtemberg) this "Universal" bronze has been used on a large scale for several years in the manufacture of every kind of machinery parts exposed to heavy and sudden stresses, such as wedges, bearings, bushes, valves, stuffing boxes, screws, screw heads, wings of propellers, runners for turbines, turbo-pumps, etc. Particularly in the construction of turbo-pumps for raising impure water or acids this new bronze has been a success.

Making Grinding Mill Rollers in Loam.

By Sidney G. Smith.

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Grinding-mill rollers are sometimes formed by assembling the requisite parts. A constant centre is used, and the circular friction part of the roller is made separate, open at one end, with the other end solid. This is passed over the constant centre, packed and stemmed with turnings between the roller casing and the constant centre, and a blank flange the internal diameter of the roller is then bolted on to the open end of the constant centre, completing the

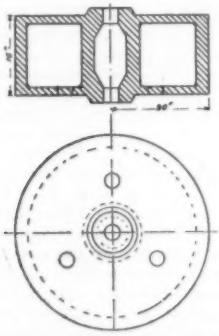


Fig. 1.—Section and Plan of Casting.

roller. This plan obviates the re-making of the complete roller every time renewal is required, for when the casing is worn through it is broken off the centre and a new one replaces it, which is perhaps not so costly as making a roller in one piece. However, when the time spent for fitting and stemming is considered, the difference in cost between an assembled roller and a roller made in one piece is practically very little, especially when the length of life of each roller is taken into account.

The following procedure (which, although common-

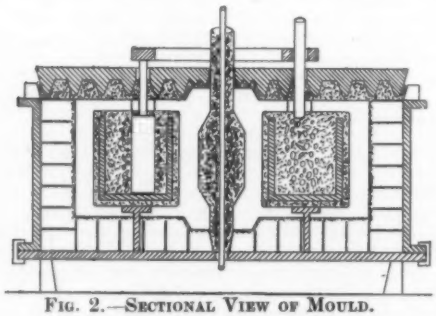


Fig. 2.—Sectional View of Mould.

place, has not yet, to the writer's knowledge, been described) relates to rollers cast in one piece, and will apply to medium sized castings of this description or even ones of several tons weight. In Fig. 1 is shown the casting, and in Fig. 2 is given a sectional view of the complete mould and tackle. Fig. 3 shows the mould striking board set, and a section of the brickwork finished. Fig. 4 shows the board set for building the core, with part of the building done. In Fig. 5 the top cake plate and board set are shown, while Fig. 6 gives sectional and plan views of the core iron as it is made in the sand.

The core iron shown in Fig. 6 is made with a quarter-circle grid pattern, the outside diameter being tramelled on a levelled bed in the sand, to which the quarter pattern should correspond; hence the circle is made with four moves of the pattern. The long prods are made the required depth with prod sticks, the sand being previously dug up, riddled, and made sufficiently firm to stand the prod stick being driven easily to the required depth, though at

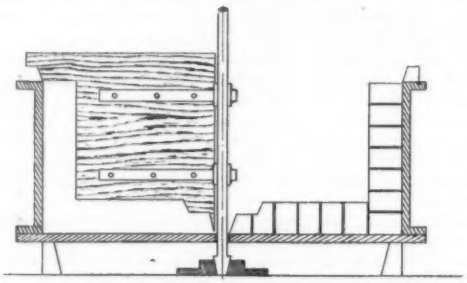


Fig. 3.—Mould Striking Board Set.

the same time the bed must not be so hard that the metal will not rest quietly when being poured.

Fig. 7 shows plan and section of top cake plate, and the arrangement of gates, stud, vent, riser, and feeder holes. Fig. 8 shows in plan and section the cast-iron ring to hold down the core. The usual procedure is followed. The only part requiring comment is the building, setting and anchoring of the core, which requires care. When commencing to make the core (see Fig. 4) the spindle cross is set and a plate rested on three stands. To obtain a true surface on this plate a thickness of about one inch of loam is strickled on, and when dried is gas-tarred for hardness, which process serves a double purpose by giving a true surface for the bottom of the core and also a guide for the core board as regards depth.

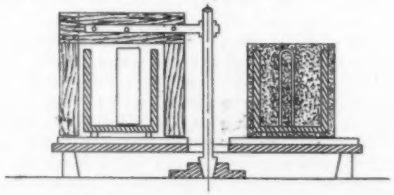


Fig. 4.—Board Set for Building the Core.

When commencing to make the core, the core iron (Fig. 6) is bedded on a layer of loam about an inch thick, prods and staples uppermost, and as the core iron is of considerable weight, three pieces of iron packing of that thickness are placed underneath the iron to keep the thickness of loam uniform. The core board is then fixed to the arm and set to size stick, after which the core iron is centred. Three bearing pieces are placed from the grid of the core iron to

the top of core, one of which is shown on the left-hand of Fig. 4 (also in Fig. 2) for the studs to rest upon when holding down the core. The core is chiefly made of stiff loam and pieces of dried loam or loam brick, with a plentiful supply of cinders. The accumulation of air and gases in a core of this kind is considerable, and must be allowed to escape rapidly, and as in this core there are only three small outlets for the escape, there must be plenty of cinder space provided, which serves the purpose of a reservoir while the excessive pressure of the gas escapes; also there must be nothing put into the core but what will come out of the three small openings, which are only 3 in. in diameter. (When the roller is for the foundry's own use the core is not always cleaned out.) The walls of stiff loam in the core are supported by the long prods, and a large space compatible with sufficient resistance in strength to the pressure of the iron is left to be filled with a large channel of cinders.

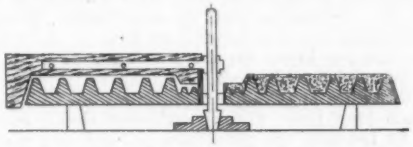


FIG. 5.—TOP CAKE PLATE AND BOARD SET.

When the core is built, stiffened and finished off with fine loam, the plate on which it is made is lifted for stoving, the core while in a green condition being kept intact. When the dried core is lifted off the plate by means of the three staples cast in the core iron, another core can be proceeded with on the same plate.

When putting the mould together the core is rested upon the three flat chaplets (see Fig. 2) previously spaced out, the stalks of which rest upon the bottom plate, the depth and thickness being determined beforehand. The chaplets must be strong enough to more than carry the weight of the core, as the wedging down which follows the closing of the mould will show.

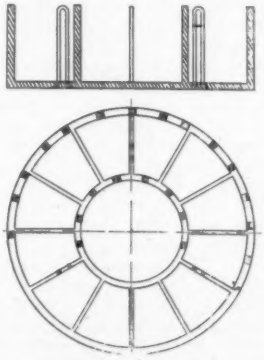


FIG. 6.—CORE IRON.

When the core is properly set and the top cake plate ready for closing, three holes are bored through the cake plate for the vents, for which provision has been made (see Fig. 7). Where the three bearings before-mentioned are in the core, three pieces of plastic clay are put, tipped with powdered chalk or slaked lime, and when the cake plate is lowered on and lifted again the lime leaves its impression on the cake plate, determining the place to bore the holes for the studs which anchor the core. Before the cake is lifted a little lime is dropped down the three holes already bored for the vents, this giving the position for boring holes into the core down to the cinders for inserting small vent pipes. In order to correspond with the holes that are cast in the top cake plate the bearings must be divided equally when

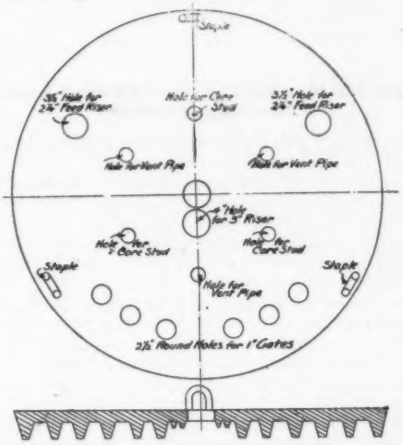


FIG. 7.—PLAN AND SECTION OF TOP CAKE PLATE.

building the core. A centre line marked with the trowel on the mould bearing, also on the top cake plate, will give radially the accurate position when closing. The air makes its escape through three small pipes 1 in. diameter which pass through the cake plate, and a piece of 3 in. round core which is set the thickness of the casting direct to the cinders.

A handy way of anchoring the studs is shown in Fig. 8. When gates and feeding pegs have been put in prior to making up, this ring is lowered over the studs and packed just clear of them from the plate. The holes allow the vent pipes to pass. Two bars or pieces of rail then cross the ring, are packed just clear of it, and are held down by either cramps, weight, or a beam, after which wedges are inserted.

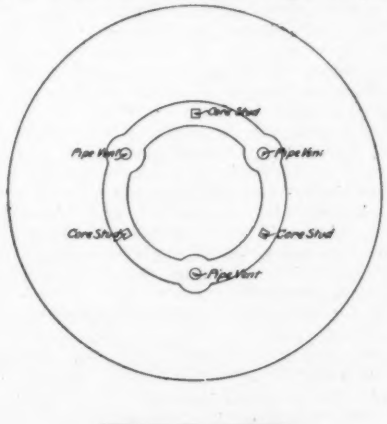


FIG. 8.—RING TO HOLD DOWN CORE.

Runner gates, of which there are six, and feeding risers, of which there are three, are then made up ready for the metal. In a casting of this thickness feeding rods at each riser are required, and one in one of the runner gates would do no harm. The centre core as shown in Fig. 2 is made in loam on a small core barrel.

Foundry Sands and their Treatment.

By Algernon Lewin Curtis, M.E.,

(*Continued from page* 19.)

Some Reasons for the Treatment of Sands and Moulding Materials.

The general principles upon which cores or moulds depend for their construction are not dissimilar to those governing the manufacture of substances like cement or porcelain, whose ultimate value depends on their homogeneity and soundness; the material difference is that the latter possess permanent shapes, whereas moulds or cores can only assume characters of a temporary nature. When gases of the air cannot penetrate a mass of concrete in its "green" or plastic state, uniform setting will not take place, and if air cannot pass through a core or mould, then gases from a casting are likewise prevented, and will consequently be entrapped, causing blowholes and cavities.

One of the first principles to be observed in a foundry is the establishment of a factor of size, or co-efficient of safety, of materials to be used in making cores and moulds. Such a surface-factor can only be determined by calculating the pressure and volume of metal necessary to be resisted, plus the pressure and volume of gases evolved. This cannot very well be guessed at, and ordinary methods will not suffice. As the questions of molten metals and refractory materials involves the subject of gases, perhaps a word on the expansion of gases may be appropriate here.

The influence of pressure greatly complicates any inventigation of the expansion of gases. Under ordinary circumstances the expansion of any liquid is independent of the pressure at which such expansion takes place. Also, the volume of a liquid is, within wide limits, independent of external pressure, because the volume of a mass of water will remain practically as constant under a pressure of 10 atmospheres as under 1 atmosphere. With gases, however, the volume is inversely proportional to the pressure. If a definite quantity of gas is to be considered before its condition can be estimated, three things must be known:—First, the volume; second, the pressure; and third, the temperature. Suppose, for example, that a quantity of gas has to be enclosed in a vessel, in order to render it in a particular state; then the capacity of such a vessel must be known, also its strength and internal temperature. (A mould may be termed such a vessel.) Therefore, the condition of a given quantity of gas depends upon three varying factors, temperature, volume, and pressure.

In order to ascertain whether any relationship exists between the three aforementioned varying factors, the results of experiments must be referred to. By "Boyle's law," the relation between pressure and volume when temperature is constant is proved. The experiment is conducted on the following lines. A large bent glass tube has one leg divided into 100 parts, the other being one-quarter the length of the former, divided into 25 parts. The gas to be experimented on is placed in the shorter closed limb, and enough mercury to enable the levels in each tube to both accurately register zero. Further mercury is then poured into the longer limb, and it will be found that as the pressure on the gas in the short closed limb is increased, its volume diminishes, and by observing the volume corresponding to different pressures, the correctness of the experiment will be found. From this it is deduced that pressure, volume equal a constant.

Having shown by "Boyle's law" the relationship between pressure and volume where temperature is constant, it is now necessary to prove the relation between volume and temperature, when pressure is constant. This means, that the change in volume of a given quantity of gas must be determined under the influence of temperature. Two methods are in vogue for performing such an experiment, those of Regnault and Gay Lussac, though that of the former is recognised as being the more accurate method, and is the one chiefly adopted.

To describe Regnault's experiment in full would take too long here, though sufficient detail can be given to indicate the principles of both the method and apparatus. The latter consists of two parts, a reservoir, in which the gas to be experimented on is placed, and a manometer. The reservoir is a small spherical-shaped glass bulb, which is enclosed in a metal vessel, and the temperature of the gas contained in the reservoir is adjusted by filling the space between the two with ice, water, steam, coals, etc. The manometer consists essentially of two vertical glass tubes communicating below by a metal bend to which a tap is attached.

The shorter glass tube is drawn out into a fine piece of tubing at its top, and bent over at right angles to connect horizontally with the gas reservoir; the second tube is considerably longer, and of uniform bore. Between the gas reservoir and the shorter vertical glass tube, a further small tube having a stop-cock, is arranged so that the interior of the reservoir can be dried by passing warm, dry gas into same, then exhausting it through the small tube by means of an air pump.

Having filled the reservoir with gas, previously passing same through drying tubes, the experiment is conducted thus:—Reservoir is first surrounded with ice, and mercury then poured into the longest tube of manometer, until the level in both tubes is on the same horizontal plane at a predetermined mark. Adjustment of mercury level can be effected by releasing air through small stop-cock, which, when complete, should be sealed. Ice is now removed from vessel, and water substituted, which is heated to boiling point. The reservoir is thus surrounded with steam at 212 deg. F., and the gas contained expands, depressing the mercury in short tube, and causing same to rise in the longer one. In a short time the mercury levels become stationary, then the tap, at bottom of longest tube, is opened and mercury runs out, its level falling faster in the longer tube than in the shorter. By closing this tap at the correct moment, the mercury columns can again be adjusted to a horizontal level. The air in the reservoir has thus expanded between 0° C. and t° C. (t=temperature), at a constant pressure, equal to that of the atmosphere, at the time of the experiment; for, both at 0° C. and t° C., the columns of mercury in the manometer have been adjusted, so as to have no difference of level.

Therefore, if the relative volumes of gas in the reservoir, in stem connecting same and that portion of the first or shorter tube between top of stem to top

of mercury are known, the mean co-efficient of absolute expansion can be calculated in the usual manner. Regnault discovered by this method the value 0.0036706 for the mean co-efficient of absolute expansion of air between 0° C. and 100° C., though for different gases the value of this co-efficient varied somewhat, especially in the cases of gas which become easily liquified. For all practical purposes, however, this result, which is equal to $\frac{1}{273}$ may be applied to most gases. It can then be stated that at constant pressure, the relation between volume and temperature is such that, if a given volume of gas be raised, at constant pressure, from 0° C. to 1° C., it will increase in volume by approximately $\frac{1}{273}$ of its original volume at 0° C. The next problem in the expansion of gases, is to discover the relations between pressure and temperature when the volume is constant. This means the determination of variation of temperature with pressure of a given amount of gas kept at constant volume.

Regnault also investigated this problem employing apparatus similar to that just described. A reservoir is filled with gas, then surrounded with ice, the mercury levels being adjusted in the manometer, as previously described. It is next heated with steam, and, as before, the gas expands, depressing the mercury in the short limb and raising it in the longer one. But it is required to find the change of pressure with temperature, at constant volume, that is, when no expansion is allowed to take place. It is, therefore, necessary to bring back the mercury column to its original position, in order to allow the gas in the reservoir to remain at constant volume. (Of course, the gas volume will be greater when heated than at 0° C., owing to expansion of glass, and in making an exact calculation this change of volume must be taken into account.) This is done by pouring mercury into the longest limb of the manometer. The height of this column will then increase, and the pressure, due to the difference in height of columns in shorter and long limbs, will cause the volume of gas in the reservoir to diminish. By sufficiently increasing this difference, the volume may be reduced to its original volume at 0°, and the level of the mercury in the short limb brought back to its original position. From this it is seen that pressure increases as temperature rises, and if, when this constant volume adjustment is made, the difference of level between the columns of mercury be noted for a given rise of temperature, the mean co-efficient of increase of pressure at constant volume can be calculated in the same way as the mean co-efficient of increase of volume at constant pressure. Therefore, the relation between pressure and temperature when volume is constant, is such that, if the temperature of a given quantity of gas at constant volume be raised from 0° C to 1° C., its pressure will increase by $\frac{1}{273}$ of its original pressure at 0° C. From these experiments it is possible to calculate the relation between Volume and Temperature with Pressure constant, the relation between Pressure and Temperature when Volume is constant, and the relation between Pressure and Volume when Temperature is constant. Such formulæ greatly assist in calculating the strength moulding materials should possess, and incidentally their size or venting properties.

Assuming the metal pressure on a core or mould is 20 lbs. per sq. in., and total air and gas pressure equals a further 30 lbs. per sq. in., the materials of which the former are constructed should be of such a size and grain to withstand such pressures; at the same time being able to liberate all gases quickly. In order to ascertain the permeability of a sand, or its capacity to vent gases, several experiments may have to be conducted, the apparatus for which can be easily put together in an up-to-date laboratory.

Before making tests, however, on sand mixtures, it is advisable to formulate sufficient data with which to check such mixtures. For this purpose, amounts of different new sands (those in use preferred) are put through sieves having meshes varying in size from 60 to 250, each being a unit of 10. The material should first be dried in an atmosphere not exceeding 200° Fah., and sieving operations continued until enough samples are obtained, whose sizes range from 60 to 250 mesh.

A given amount of material, having been weighted and its size noted, it is put into a graduated glass cylinder, the latter's internal area being so constructed that its area measures an inch or some fraction of an inch. A gauze burner is fitted to the cylinder bottom, and the whole suspended horizontally, while the other end is attached to a gas receiver, the latter having a pump and delicate pressure gauze fixed on the pipe connection, so that pressure and volume of gas can be easily regulated. Gas is then pumped through the sand in the cylinder and lighted; the length of flame and point of ignition in conjunction with the pressure of gas forced through are indicative of the sand's venting qualities, and establish a vent factor for a fixed size of sand. Smoke may also be used, and length of stream be taken as a basis for calculation.

When using apparatus like a glass cylinder and employing gas, or smoke, it is advisable to have a detachable metal cap for fitting on the cylindrical bottom, and a small spring balance plunger pump for working inside the cylinder, so that the material can be compressed by the pump to any pressure equalling the density of a core or mould occasioned by the moulder or core-maker when ramming.

It should not be forgotten that the operation of passing a sand through, say, a 100-mesh sieve is responsible for the loss of much of its clay; therefore, the original clay content should have been previously determined, and the proportionate amount added to each sample to make up for such loss. After establishing the vent factor of each grade of sand in units of 10 mesh samples of sand mixtures in use can then be tested and results compared. Another good way to determine the venting properties of a moulding material, and also, what is equally important, the actual volume of gases given off from a given weight of metal, sand, water and compound, and the actual pressure at which such gases evolve, is as follows:—Special flasks are prepared that are air-tight, having scraped joints, with solid tops and bottoms, the former having apertures for pouring. In construction the flasks should be such that vent pipes from the flasks are provided and connected up to a gas receiver. Diaphragm pressure gauges should be fixed on exhaust pipe connections, and a gas receiver so constructed that volumetric measurements can be made. When the mould is poured, the evolving gas pressures can be taken and noted in connection with the temperature of molten metal; also the total volume of gas given off from a casting of known weight, sand, water and compound.

The gas and metal pressures having been ascertained by such experiments, will reveal the venting value of sands having large particles, and being uniform in character. Thus it would seem that venting should depend upon size of sand particles, their density, and amount of organic matter and water contained.

Tests by other means have been employed for establishing vent factors, and one of these is the "water test." but permeability should not be confused with "capillary action"; and though the water test is extremely useful for determining the latter, many things prevent its being used in this connection, especially the changes which take place in materials

due to the action of water, causing fissuring etc.

In the examination of a common new moulding sand, it may be found that from 10 to 25 per cent. of the sample will stay on a sieve of 100 mesh; up to 50 per cent. will remain on a 200-mesh screen, and the balance consists of intermediate-sized particles and dust, the latter being chiefly clay. From this it can readily be seen that a sand in its natural state is made up of an extraordinary number of different sized particles. If a sample of such sand were put into a clay mixing (not grinding) mill, with an excess of fire clay, and were moistened either with water, oil, molasses, or any organic compound, the product when taken out after mixing would, if rolled out in thin layers on white paper sheets mounted on glass, show that the clay and fine sand particles were very closely associated; whilst the larger particles existed separately with little or no bond between their facets. If such a mixture is used in a core or mould, the large sand particles will be too weak, and the dust particles and clay which have fallen to the bottom, being heaviest, now exist in a thick mass, made more so by ramming, and being nearest the molten metal cause much trouble. Perhaps some founders have seen the extraordinarily fine products of "counterfeiters," made possible under difficult conditions. The reason why such coins pass is because their moulds are perfect; and if such moulding materials were not prepared with the greatest accuracy, wasters would result every time. It may seem a big jump from casting a five-shilling piece to a steam cylinder or steel ladle; but the principles are the same in all cases.

The value of a sand, therefore, depends upon the bulk of its particles being uniform; and if a sand is 33-66-99, or in other words, contains ⅓-100 mesh, ⅓-200-mesh, and the balance dust, whichever grade is required demands the removal of the other two.

Such remarks apply chiefly to new sands, as when the field of old sand is entered, further phenomena are revealed. To begin with, the bulk of old sand has been ground or reduced in size in pan or other mills, until much of its original size has become lost, and is therefore dust. Sand of this description must be used with great care, but old sand which has not been ground is just as good as new sand after proper screening and treatment.

One reason why great losses occur in steel foundries is because crucibles, gannister, clinker, and other substances are ground in pan mills, then after screening the product through a 10-mesh sieve, it is put into another pan mill with sand, clay, etc., and reground, the original material perhaps containing a dust content of 15 to 30 per cent This latter is saturated with organic substances for strength, and such excess will prevent escape of gas. In other steel works, however, every particle of sand or moulding material is properly graded and treated.

To state that old or dead sand cannot be used again is an error, either in small or great quantities, until same has been examined by a person competent to pass an opinion. If old sand has not been ground, it can be used in large quantities; if it has been ground, the amounts must be reduced. The practice, however, of throwing old sand away is not only a costly one, but should be discontinued until the materials have been examined by an expert. Because old or dead sand has lost its clay does not justify its discontinuance, but rather tends to improve its qualities. It is certainly easier, and much more economical to take 100 lbs. of clay to renovate a ton of old sand, than to move the whole ton away, which must eventually be replaced by a ton of new material. Founders should therefore be very reluctant at dumping their old or dead sand, until an experienced man advises on such a course. Having pointed out a few methods of detecting the component parts of a natural sand—and such remarks are specially intended for steel founders—it now remains to give a few reasons why sands that have been made uniform should be properly treated.

The chief elements in a moulding material are either clay and silica material, or clay and silicious material, the former being used chiefly in steel foundries. Assume that a sand has been properly prepared for treatment, *i.e.*, the organic matters have been removed and the particles properly graded, while its condition is such that though some moisture has been eliminated, its nature is not harmed, and is capable of taking up further quantities; in order to bond or cement the grains or particles together a suitable clay is necessary, also some form of reagent, to act on the clay to establish the latter's plasticity. For iron work, coal or coke dust is sometimes added, but in steel castings the different nostrums and secret remedies are innumerable.

Just one word about secret remedies. Whether in the manufacture of iron, steel, aluminium, bronze, or brass castings, all such remedies, said to be of priceless value, are practically worthless outside their own foundry gates. Given a good hot metal, of the correct mixture, and men who know to 10 deg. C. what metal is, good moulders who can "feel" a mould, fine castings can be produced every time, if the moulding materials are rightly composed, properly graded and efficiently treated.

These remarks are not meant to convey that trade secrets do not exist, or are of no particular value, because judging a heat is a secret, also knowing what heat to judge. Every founder knows a composition wants clay, which is not a secret; but the secret is in knowing how much clay and of what particular kind. Such knowledge of the amount of clay "X" uses in a mixture is no good to "Y," whose sands may be of an entirely different base, whose work may be totally different, and "Y's" men may be following a certain line of work quite different to that carried on in "X's" shop. Readers should, however, not be confused, and confourd knowledge with secrets, because the former necessarily embraces the latter.

Reverting to the question of sands ready for treatment, it should be observed that not only has it been necessary to prepare the sand, but it is just as necessary to prepare the clay also. This latter can be done by those people whose special business it is to prepare clays, and therefore need not be put upon the propaganda of the founder. The trouble is not in preparing the clay, but to find a suitable reagent which will act quickly and effectively on the dry clay particles enablng same to assume the proper degree of plasticity.

As is well-known, all kinds of glucose will affect the plasticity of clays, more so than water, though it is necessary to use water as well, and sometimes oil. Here again the question arises, how can the atoms of a reagent be brought into contact with the fine particles of clay? It cannot be effected by the handy though crude method of watering with a can or bucket. It must be performed under pressure, so that such a reagent is broken up into atoms in the form of spray, its range covering the bulk of material, and ensuring a uniform operation. Whatever form of reagent is used should be sprayed under pressure on to materials during the process of mixing, so that at frequent intervals fresh clay particles become exposed and therefore impregnated.

When enough spraying has been done, and this is determined by the condition of material, tests being frequently made to ascertain the live qualities of the clay, the mixture being in more or less sticky condition. It will then occupy a larger volume than before, be more open, and like brown sugar. The

reagent has livened it, causing the clay to expand, which forces one particle away from another. To use such material in this state would be impossible, and to put same into a pan mill would be to undo what has been already done. The proper treatment, therefore, is that of kneading or rolling in such a way that the clay, which was originally dust and now resembles globules, is compressed until it oozes out between the sand particles, thus reducing its volume and being toughened all the time. By specially constructed machinery which will be described in future chapters, the operation of kneading is successfully carried out.

(To be continued.)

Mechanical Properties of Metals at High Temperatures.

Before the London Branch of the British Foundrymen's Association on January 10, a lecture was delivered by Mr. F. C. H. Lantsberry, of the Birmingham Small Arms Company on "The Mechanical Proprieties of Metals at High Temperatures." The following is an abstract of the lecture, which was illustrated by a number of slides showing the equilibrium diagrams of the alloys discussed and charts of the test results:—

Notwithstanding the immense importance of this subject both to the engineer in the construction of modern high speed engines and to the metallurgist in the hot working of metals, scant attention has been given to it. Early experiments were crude in character, but the use of electric resistance furnaces has rendered possible for execution of accurate tests. The work of Martens, Webb and Huntington indicate that wrought iron and mild steel attain a maximum strength between 250 deg. and 300 deg. C., after which the strength decreases rapidly. At the same time the elongation first diminshes, then increases and above 400 deg. C. falls away rapidly. In the case of copper, however, both the strength and ductility diminish with increasing temperature, the rate of deterioration of mechanical properties depending on the purity of, and the amount of work which has been put on the metal. Aluminium decreases in strength and increases in ductility as the temperature rises. A glance at a few equilibrium diagrams indicates that the alloys of commerce, brasses, bronzes, aluminium bronzes, etc. are of two kinds:—

(1) Single-phase alloys; and (2) two-phase alloys. These two classes of alloys have different properties and uses; *e.g.*, the single-phase or α alloys are used for drawing and cold working, while the duplex or $\alpha + \beta$ alloys are used for hot working. Mechanical tests show that while the ultimate strengths of all the alloys fall off with increasing temperature, the ductility of the single-phase or α alloys diminishes continually, and the ductility of the duplex alloys at first increases with increase of temperature. This has been shown to be the case in brasses, aluminium bronzes, and aluminium-manganese bronzes, and the increasing ductility of the duplex alloys is due to the fact that the hard brittle β phase becomes softer and more ductile on heating.

Study of mechanical tests at high temperatures led Bengough to the discovery of mechanical critical points. The increased strength of worked (rolled or drawn) material is generally ascribed to the formation of amorphous matter between the crystals themselves and the gliding planes during the process of deformation. Even the process of testing is sufficient to produce this material, but it cannot exist above a certain temperature, which temperature is marked by a discontinuity in the temperature-stress curve. This point has been called by Bengough the limiting temperature of recuperation.

Discussion.

Mr. J. W. Horne (Branch President), in opening the discussion, referred to the lecturer's work at the National Physical Laboratory as an assistant to Dr. Rosenhain. The subject dealt with in the lecture was becoming one of great industrial importance, and as an instance of that he recalled the fact that at present, at least one firm were producing steel castings with the properties of rolled steel, and this by means of heat treatment. This alone showed the importance of the research work which had been conducted on the subject.

Mr. Boote said that Mr. Lantsberry had referred to "ductility as represented by elongation," and had further remarked that elongation was not always a true measure of ductility. Could he elaborate that statement and explain why elongation was not a fair measure of ductility, and also state what was a fair measure? Further, what was the actual effect of overheating a metal.

Mr. Willis raised a question regarding the retention of heat by alloys of aluminium. Could the lecturer explain why a slight alteration in the proportion of constituents, as, for example, in the amount of tin, caused the metal to remain at one temperature for a long time?

Mr. E. Kilburn Scott discussed the trouble which engineers experienced with gas turbines owing to the high temperature which had to be withstood. There was no metal in commercial use which could stand the temperatures attained, and the question called urgently for investigation, since progress in that branch of engineering was stopped by the difficulty in question. He suggested as a possible remedy the electrical sintering of magnesite on to the surface of the metal. He had employed magnesite in that way for surfacing the interior of electric furnaces, and the result had been excellent. Another problem was presented by the mining industry. Owing to the high temperature of the atmosphere rising through the upcast shaft, it was usual to run cables into the mine by way of the downcast shaft; but it would often be more convenient to send them down the downcast shaft if a metal could be got to stand the heat.

A member desired to know why, since the alpha or single-phase alloys were better worked cold, the annealing common with, for example, 70 : 30 rolled brass was necessary.

Mr. Lantsberry, in answer to a question regarding manganese, said it would be expected that an increase in manganese would increase the tensile strength of an iron at high temperatures. The effect of manganese was to retain the carbon in the combined form. Replying to Mr. Boote, the reason for considering that elongation was not a true measure of ductility was that copper worked better at high temperatures, though the chart showed a lower elongation; generally, however, elongation could be taken to represent ductility. As to overheating, there were two effects produced; under some conditions overheating caused large crystals to form, and under other conditions it caused oxidation between the crystals. Regarding the annealing of 70 : 30 brass, this was necessitated by the fact that in the process of rolling the crystals became elongated. The annealing, however, restored the crystallisation. In reply to Mr. Willis, the phenomenon of retention of heat by the aluminium alloys was probably due to the fact that the specific heat of aluminium was very high.

A hearty vote of thanks to the lecturer concluded the meeting.

The Metallurgical Work of a Motor-Car Factory.

An interesting book, entitled "Notes on the Materials of Motor-Car Construction," by Mr. A. E. Berriman, has just been published by St. Martin's Publishing Company, 44, St. Martin's Lane, W.C. Written with special reference to the Daimler Motor-Car Factory at Coventry, it embodies a great deal of information gleaned from that source, and contains much of interest to the student of motor-car construction. The very difficult task of placing the contents of the book within the comprehension of the average car user, also, has been creditably performed, and this in itself ensures a book of a not too highly technical character. Metallurgy, naturally, is a prominent subject in connection with the materials under consideration, and the descriptions of the metallurgical and metallographical work in the Daimler laboratories is of more than passing interest, as it represents first-class modern scientific control. The second part of the book is of a more technical character than the first part, and to the laymen would prove a revelation regarding the varieties of material and their treatments which go to the making of modern engineering appliances. The outstanding feature of the work is the microscopic study of the metallurgy of the automobile, and the author has drawn extensively upon the records of the metallurgical department of the Daimler Company. As regards the manufacture, the particulars given of the "Stock" oil-fired converter which is used are of interest, particularly as this is the first furnace of the kind to be installed for motor work. In the non-ferrous work a brief account is given of the exhaustive experiments which were made in order to arrive at the composition of the "S.P.B." phosphor-bronze employed for the worm wheel in the back axle drive now used on the Daimler cars. This is cast in such a manner as to chill the outside or wearing surface and to produce homogeneity and fine grain where it is most required.

The foundry is depicted in Fig. 1, which gives a general view as seen from the cupola platform. Here are produced all those parts which can be cast in iron, steel or bronze. Fig. 2 shows some of the brass moulders pouring the castings, while in Fig. 3 are shown the coke-fired crucible furnaces which are employed for melting the metals which are required in small quantities. The charging platform of the cupola is depicted in Fig. 4, whch shows the various brands of iron, the coke, and a portable weighing-machine for weighing the charges.

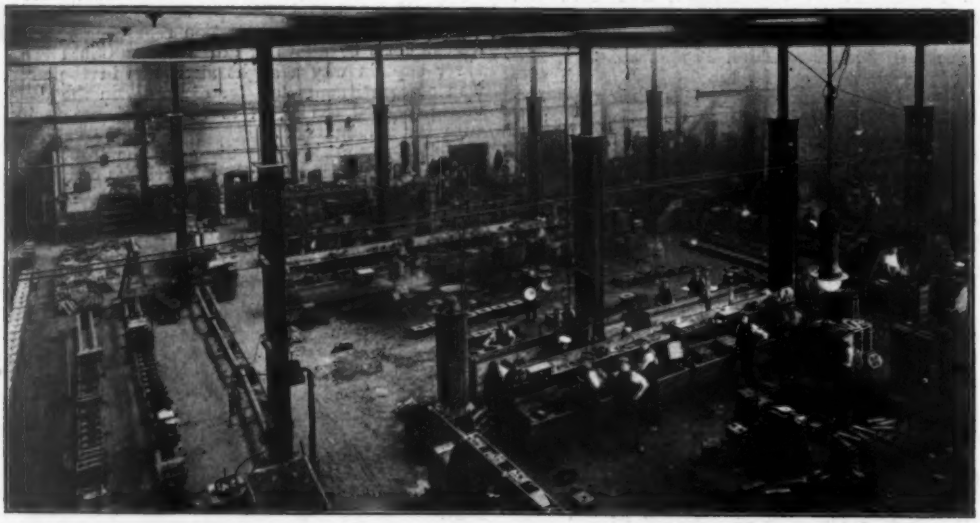


FIG. 1.—VIEW OF PART OF DIAMIER FOUNDRY, AS SEEN FROM CUPOLA PLATFORM.

As the author of the book mentioned above remarks, core-making is something of an art itself, and one, moreover, that a good many men have well-nigh grown grey over, for the only suitable material to use is sand. One might imagine that sand was sand all the world over, but the varieties are numerous enough when they are really investigated, and some are much better suited for moulding purposes and core-making than others. Respecting the latter, the Daimler metallurgical department have found, after much research, a preparation of sand that gives them quite remarkable results. Rather like moist sugar in appearance, it has the uncanny look of being alive, for its particles are on the move for hours after a handful of it has been placed in a heap undisturbed. It possesses excellent moulding properties, and when baked it is very strong and possesses a metallic-like hardness, so that it can be handled without damage.

Machine moulding is largely employed in the Diamler foundry, and in order to rapidly and efficiently clean the castings after they come from the mould, and to remove scale from the surface of either castings or forgings, sand blasting is employed. The plant for dealing with cylinder

castings and fairly large work comprises an air-tight steel chamber, a fettling table, and flexible tubes made to deliver, by means of a compressed-air blast, a stream of chilled iron shot on to the surface that is to be cleaned. The operator, suitably protected by a leather helmet surrounded by sheet rubber to preserve it from the rebounding sand, directs the blast on to the work in front of him, his eyes always being protected by a transparent material such as celluloid or fine gauze. The upper portion of the helmet receives pure air for breathing and ventilation, while the vitiated air passes out through the loose portion of the hat. Fig. 5 shows the sand-blasting chamber with the operator at work.

With smaller work, the method adopted is rather different, being, in fact, an adaptation of the tumbling barrel. The castings are enclosed in a slowly-rotating cylinder, and the blast is applied through one or both ends of this, the rotary motion of the barrel causing fresh surfaces constantly to be exposed to the cleaning action of the shot. Reduced pressure is maintained in the barrel, thus preventing the escape of the finer sand or dust removed from the castings; any air leakage is obviously inwards only. A suction apparatus recovers the good shot, separating it at the same time from the dust. That the sand-blast method is economical in both time and labour needs no further proof than the fact that a barrelful of small brass castings can be finished in an hour, whereas by hand brushing four men

FIG. 2.—VIEW IN BRASS SECTION OF DAIMLER FOUNDRY, SHOWING MOULDS BEING POURED.

FIG. 3.—COKE-FIRED CRUCIBLE FURNACES AT DAIMLER FOUNDRY.

would be employed for a whole day on the same task. At the Daimler Foundry the whole of these sand-blasting, cleaning, and fettling operations, and

FIG. 4.—CHARGING PLATFORM OF FOUNDRY CUPOLA AT DAIMLER WORKS.

the subsequent redistribution of the materials are confined to a separate department outside the foundry proper.

(*To be continued.*)

FIG. 5.—SAND-BLAST APPARATUS AND CHAMBER FOR CLEANING CASTINGS.

THE BRITISH "NICLAUSSE" BOILER COMPANY, LIMITED, Caxton House, Tothill Street, Westminster, London, S.W., have recently installed a large boiler at Messrs. Siemens Brothers' works at Stafford, and are taking steps to construct their boilers and mechanical stokers in this country. Mr. W. Yorath Lewis was recently elected managing director of the company.

British Foundrymen's Association.

Sheffield Branch.

The Sheffield and District Branch of the British Foundrymen's Association held its annual meeting on January 21, 1913, Mr. Percy Longmuir, M.Met., presiding. The report of the Branch Committee stated that during the year 15 new members had been elected, three had resigned, and 14 had been transferred to the new Halifax Branch, so that the membership of the Branch now totalled 95, compared with 97 twelve months ago. The subscriptions should amount to £56 17s., but only £36 8s. had been received, and 38 members were in arrears.

During the year seven meetings have been held, including two joint meetings with the Society of Engineers and Metallurgists. The amount in hand last year was £9 10s. 10½d. as compared with £11 14s. 2½d. this year.

MR. LONGMUIR thought the report indicated a very healthy outlook so far as Papers and discussions were concerned. The membership, he felt, was not at all bad, though the amount of arrears shown was regrettable, and should be remedied. There was also room for improvement in the matter of attendances. The level of their Papers was high. In fact, the

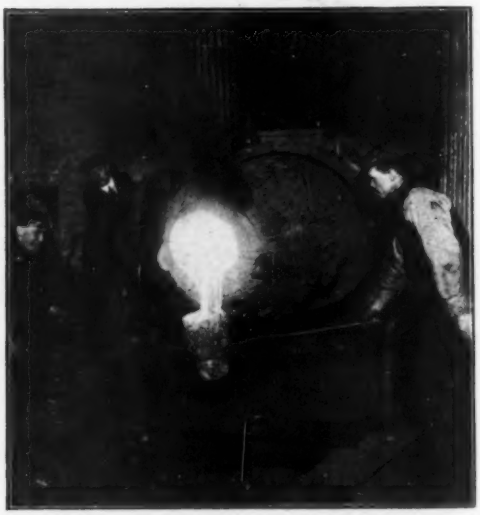


FIG. 7.—POURING THE "STOCK OIL-FIRED CONVERTER FOR STEEL CASTINGS.

Foundrymen's Association, as a whole, for the quality of its Papers, need fear comparison with no similar organisation. But he could not help wondering why in a town like Halifax they could get audiences larger even than at Sheffield. Was it that the Sheffielders did not like parting with their information? Whatever the cause, he felt it very desirable that they should stimulate their members to greater activity. Such associations were bound to have an influence upon the productions of a country in many directions, and those members who supported them most keenly would derive the most benefit. Mr. Longmuir added an acknowledgent of his obligations to the members of the Committee and the officers for their support during his three years' Presidency, during two of which he had also held the General Presidency of the Association. He proposed as the President for the coming year, Mr. Firth, who was in most intimate touch with the practical, technical, and commercial side of iron-foundry.

Mr. Oxley seconded, and the resolution was unanimously carried.

Mr. Firth briefly acknowledged the compliment, and proposed the election of Mr. Samuel Osborn as Senior Vice-President. This was seconded by Mr. Redmayne, and enthusiastically agreed to. Mr. J. G. Crowther was elected Junior Vice-President, and Mr. R. W. Kemlo re-elected Hon. Secretary, and heartily thanked for his past services. Messrs. L. Redmayne and W. H. Oxley were appointed auditors, and to fill vacancies on the Committee, Messrs. S. G. Smith (Chesterfield), J. R. Hyde, F. K. Knowles (Sheffield University), and J. E. Short, were elected.

Presidential Address.

Mr. Thos. H. Firth, in his Presidential address, said he did not think that in the foundry there had been made the rapid improvements that other trades had witnessed, considering that the knowledge of ironfounding could be traced back to the 15th century, when cast-iron cannon balls were made in Germany. England, however, was the first to make cast-iron cannons, which were exported to Spain and used against England's ships in the wars of Elizabeth. After this the field of use for cast iron gradually widened, and in 1685 the first cast-iron water pipes were made; then flanged pipes followed, and next flask casting was patented in 1708 by Darbey, who became later the founder of the Coalbrookdale Works, and soon after the first cast-iron bridge was made. Cupolas were first brought into use in England in 1764, and very soon after, Wilkinson became the founder of the modern ironfounding industry. It was recorded that the first cast-iron kettle was made at the Sangus Ironworks, Massachusetts, as early as 1642.

However, the ironfounding had advanced at a less rapid rate than the iron and steel industries, especially steel. Though steel castings had to a very large extent replaced cast iron, yet there could be no doubt that there was still a very large field left for the ironfounder, and with judicious management and modern appliances a little money could still be made. Economy of fuel, selection of pig-iron, electric crane equipment, moulding machines, improvements to cupolas and air furnaces, all helped to ensure success.

Much could be said about the grading of iron, and with the aid of the chemist, who had been very helpful, great strides had been made in the direction of suitable mixtures for special purposes. In many castings sulphur and phosphorus were most injurious, and unless analysis were constantly resorted to, trouble would be experienced, especially if the pig-iron maker was under the impression that there were no analyses taken. In the melting of metal for large castings (75 to 100 tons) it was a great help to have reverberatory furnaces which could be used to obtain very hot to mix with the cupola metal (some of which had to stand a long time). At the Newhall Works of the Brightside Foundry Company, there were three of these, the largest of which would hold upwards of 20 tons. These furnaces refined the iron, but care had to be exercised not to keep the metal too long in the bath after all of it was melted, as it would very easily spoil by burning. He had known very open hematite come out mottled and white by being kept in the furnace too long. There could be no doubt that although melting in the air furnace was much more costly than the cupola, the extra refinement and strength obtained much more than compensated for the extra cost. The iron for all castings over, say, two tons, requiring great strength, such as rolls, etc., should certainly be melted in this way.

He had just returned from Düsseldorf, where, as in England, not many alterations in the iron foundries had been made during the last twenty years. There was no doubt, however, that enormous strides had been made there in engineering, and English competitors would have to wake up. At Düsseldorf it was being realised that cast-iron could not be dispensed with, and at one works, which was established in 1873, and where the whole of the engineering plant and shops had been remodelled during the last three years, the managing-director expressed the wish that the alteration of the foundry, which was now being commenced, had been done years ago.

One of the great necessities in the iron foundry was to watch the cost. His own practice was to take out the cost of every casting and to have the cost of moulding of every casting made marked in the day-book. If there was a repeat order for castings made a year previous, it would be the cost clerk's duty to report if the cost came out higher, and the cause would be at once gone into, and altered, if possible. Foundry foremen were recommended to examine all patterns coming in from customers before they went into the shop, as very often a few shillings' worth of alteration in the pattern shop would save pounds in moulding. Patterns were very often made by outside pattern-makers at a given price, whereas if the customer paid a little more for the patterns he would buy the castings for very much less per hundredweight. There was no doubt whatever that costs could be kept down by not being afraid of making new boxes and tackle, and it might be a wise precaution, if a dozen castings were to be made, to see that the boxes were just right for the work, and if not, to have some made to suit.

A vote of thanks to the President for his address was heartily accorded, and briefly acknowledged by the President.

The Manufacture of Brass.

At a meeting of the Birmingham Ironmongers' Assistants' and Hardware Clerks' Association, held at Queen's College on January 22, a lecture was given by Mr. A. J. Croft, on "The Manufacture of Brass." The speaker described the methods of production and gave illustrations showing the great improvement in shop equipment. As an example of an up-to-date foundry, unsurpassed in any part of the world, he cited the foundry department of the Birmingham Aluminium Company, which finds employment for 500 moulders. Wherever possible, well-lit benches were being used by founders for moulding, instead of the sandy floor "with a farthing dip." Another improvement was the use of band-saws for cutting off the "gits" from the castings, in preference to the old method of a hammer and chisel, which often enough injured the casting. As an example of the care taken, the speaker mentioned that in most modern foundries the ingots made from scrap brass were carefully analysed, and the utmost care taken to secure uniformity in composition. He stated that there were now hundreds of alloys having the name of brass, and gave the analyses of a number of these. In regard to manganese bronze, he pointed out that this was a very valuable material, which could be cheaply produced, and, if well made, was considerably stronger than the best mild steel. But the majority of Birmingham brassfounders were frightened of manganese, and thought that if a little of it got into their castings they were on the road to ruin. They attributed their bad castings either to manganese or aluminium.

Correspondence.

Education in the Foundry.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Reverting to the correspondence on this subject in your December issue and the criticisms of the suggestions as to industrial training put forward by Mr. Alexander Hayes, I will not attempt to answer them, for that has already been done quite well. But at the same time, I am much amused by the attempt to raise the bogey of the "Trusts" in order to scare off those who would attempt to interfere with the old idea of apprenticeship. The writer of the Paper is quite right in stating that the apprenticeship system is dying a very natural death—the conditions which made it possible and desirable do not exist to any great extent to-day, and since the system has not adapted itself to the new atmosphere, it can only live where some remnant of the old atmosphere survives. When, however, we are told that the small employer must be encouraged and that the Trust must be fought, it becomes necessary to enquire into their respective virtues and vices. While acknowledging the advantage in training which the small shop gives, in the way of varied work, I must contend that in very many small shops the conditions are bad for health, the equipment is such that had it been human a beneficient Government would have pensioned it off long ago—and the methods of working taught are such as form but a poor preparation for following the trade in a modern shop. This, it is true, does not apply to all small shops, but it certainly does to a good many; and, moreover, there is no guarantee that a boy will be taught his trade there than in any of the larger places, for he can equally well be kept at easily-performed operations and unskilled jobs till he gets too big for the work, and gives places to another.

On the other hand, we may examine the statement that "Trusts mean extreme specialisation." Now this may be an accepted opinion, but it is only half the truth. Trusts stand first for the elimination of wasteful competition, the economic organisation of production, and for such specialisation as is deemed necessary for increased economy. But that specialisation is by no means peculiar to the Trust. Because the Trust idea, when carried to certain extremes, presents undesirable features, we must not necessarily condemn the organisation as a means to greater economy. It is too big a task to discuss the Trust question fully in these columns, but I may point out that exactly the same principle of combining small industrial plants in one large and well-organised concern is the basis on which have been built up most of our great works in this country—works of which we are justly proud; and it can scarcely be claimed that those large works are only prevented from becoming a menace to the nation by reason of the "little master" and his competition. It must be remembered that large organisations with corresponding capital are an absolute necessity for the conduct of many of our industries on lines that will compete in the world's markets. If the conditions in any country are such as allow this organisation for efficiency to develop side features which are detrimental to the national life—well, the sooner the nation in question wakes up to its responsibilities in the regulation of its own industries, the better; and until then it deserves what it gets. But, pray, don't downcry efficient organisation of industry simply because the science of controlling it has not yet been properly learned.

This may be somewhat off the track of education proper; but what I wish to protest against is the introduction of ill-considered and illogical objections which only cloud the real issue.

Yours, etc.,

"REFORM."

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I have read with interest the Paper on "Education in Relation to the Status of the Foundry," by Mr. Hayes, and would like to suggest that the questions raised apply to practically all those industries which employ both skilled and unskilled labour—in particular when the author very rightly condemns the uselessness of the existing system of elementary education as a preparation for industrial or business life. This is particularly noticeable in the building and allied trades, which, while forming perhaps the largest industry in the South of England, are the only ones for which any course of special training is given in the elementary schools.

In spite of the tremendous sums expended on what are called "technical subjects," the proportion of scholars who have the slightest ideas of mechanics or construction is infinitesimal, and it is highly probable that the few successes which are recorded would be attained quite as well without the technical classes, more being due to the scholars' own natural aptitude than to actual school training. This is apart from the fact that a large proportion of the boys who go through these classes do not follow these callings in after life.

The same applies to business life, where, although most elementary schools now include in their syllabus algebra and mathmetics, shorthand, correspondence, and languages, it is extremely difficult to find an elementary school scholar who can either handle vulgar or decimal fractions, or write a letter in good, sound business English and good handwriting. In short, it is an admitted and very lamentable fact, that modern elementary education not only is useless in preparing children for industrial life, but actually unfits them, by filling the memory with half-digested data and unapplied theories on numerous subjects, while the reasoning faculties lie dormant during the most susceptible part of the child's life. In this lies the secret of the old school of craftsmen, who, starting with a limited education, or perhaps none, obtained their knowledge by a combination of investigation and practical application, so that every idea was the result of a strong mental effort, directed toward a definite end, and every result was achieved by clear reasoning, and not confused by the misapplication of badly memorised rules.

At this point I must disagree with any suggestions as to widening or elaborating the field of study attempted in elementary schools. The average child would never master the subjects unless the age limit were put up to 18 years at least, which would impose a breaking strain on the financial resources of ordinary parents in this class, besides which, as the trade to be followed by each scholar is seldom decided during school life, the ground covered would need to be enormous to be of use. There is at present ample means of self-education in the evening classes, public libraries, and other institutions, to be enjoyed by any beginner who has interest in his work; while in every organised trade the hours are sufficiently short to permit of as much spare time study as any healthy mind requires.

My own suggestion would be to limit the syllabus of the elementary schools to the simple study of the English language (with, of course, reading and writing), simple arithmetic, geography, and especially logic, with an advanced course during the last years of school life, say, from 12 years to 14 years of age, for those scholars who proved efficient in these studies. This would be as much school training as the aver-

age lad requires on entering a trade, and would leave his mind free to tackle the details of his craft, while giving him those elements of education necessary to enable him to learn properly whatever trade he took up. The actual working practice is obtained far more quickly and correctly in the course of apprenticeship, and if all the school training were devoted to leading out the natural reasoning powers of the scholar, the result would be shown in a far more intelligent class of workers than that produced by the present so-called elementary educational system.

The social aspect of the questions raised by Mr. Hayes regarding the low-standard of certain sections of the industries, is the result of dividing and specialising labour in these industries, in which the use of advanced machinery and scientific methods has definitely separated the skilled from the unskilled portions of the work, opening up the higher branches to a more highly trained and cultivated class by increasing the wage-earning capacity and refining the conditions of labour in that section, and leaving the purely unskilled labour to a class who at one time never entered the industry, and who rarely make any effort to improve their positions.

Yours, etc.,

HERBERT LAWRENCE.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In reply to Mr. Gordon's criticisms of his paper on this subject, Mr. Hayes remarks that "any supply of labour which can be made a source of profit to an employer automatically becomes employed, and at a rate in keeping with the value to the employer." Leaving out the question of trade depressions, and other passing influences which tend to place valuable labour idle, I cannot see that the rate paid is always "in keeping with the value to the employer." Perhaps Mr. Hayes can explain why what we know as sweated labour is still to be found in many trades. Can it be that the value of the work is only that which is actually paid to the worker?

Yours, etc.,

"QUERITUS."

Reply.

I frankly admit that the existence of sweated labour appears to contradict the statement quoted above; but before that conclusion is accepted, the term "value" must be defined. It was used in the sense of indicating that quality or property which could be applied with profit to the employer under commercial conditions. Value in this sense (purely a commercial one) must not be confused with *usefulness* as measured by the ultimate service to the community given by the product in question. The usefulness of either labour or a product of labour can only be measured by its capacity to serve some demand or requirement of the community. On the other hand, regardless of that service on the part of the product of labour, its *commercial value* may be either high or low. Excess of a special class of labour supply may cause competition for the opportunity to operate at a certain work, with the result that the wage paid may be far below that which would represent the usefulness or service of the product to the community. Sweated labour of any class would not exist if the supply of that labour were regulated to the requirements of production in that special line. But since most production is carried on under competitive conditions between employer and employer, the value of any class of labour to an employer is no higher than that at which a competitive employer can secure the same labour. It will thus be seen that though "any supply of labour which can be made a source of profit to an employer becomes automatically employed, and at a rate in keeping the value to the employer," that value may bear no relation to the value of the labour as such—its value to the community as measured by its usefulness. The essence of the whole question lies in the fact that the commercial value of any article is only a measure of its purchasing power or exchangeability (determined by the quantity available in relation to the demand), and not of its usefulness or actual value.

ALEXANDER HAYES.

"F.T.J." Bookshelf.

he First Railway in London.

By Alfred Rosling Bennett, M.I.E.E. London: The Locomotive Publishing Company, Limited, 3, Amen Corner, Paternoster Row, E.C.

This is an interesting illustrated brochure of 48 pages, presenting the story of the London and Greenwich Railway from 1832 to 1878. To those who are accustomed to the magnificent net-work of railway systems which serve our industries in almost every quarter of the country, it is difficult to imagine that within the memory of living man the first railway in the Capital was laid down. The pleasing sketch of the history of the none too fortunate London and Greenwich Railway Company, which is presented in this brochure, is at once a tribute to the energies of early railway engineers, and evidence of our rapid industrial development during the last hundred years. When the railway in question was started, the population of what is now known as Greater London, was only about 1,767,000, whereas it is now about 7,253,000. This growth of population round one centre, even though it be the Capital, could never have taken place without the aid of the railway systems which have been brought into being during the same time. In this account of the first London railway the author has embodied much interesting local detail and personal reminiscence, which render its perusal both pleasing and profitable.

The Manufacture of Iron and Steel.

By H. R. Hearson. London: E. & F. N. Spon, Limited, 57, Haymarket, W.

In the space of 100 pages, the author has aimed at summarising the subject of the manufacture of iron and steel from the ore to the finished ingots, and including remarks on mechanical testing and the heat treatment of steel. It will be readily conceived that the scope for each side of this large subject is not great in such a small volume; but the author has condensed most of the essentials in a way that will appeal to the non-technical reader. The style is very simple and straightforward, making the book a suitable primer for class work. It is doubtful, however, whether there is much call for such a brief survey of the subject amongst engineering students, to whom it is suggested it may be useful, though as a simple introduction to the manufacture of iron and steel the book is commendable.

THE BRITISH ALUMINIUM COMPANY, LIMITED, 109, Queen Victoria Street, London, E.C., have issued a very useful little booklet, giving in condensed form information relating to aluminium. The particulars include the sizes of ingots and billets, slabs, rods, bars, plates, tubes, cables, wire, and also aluminium in the form of casting alloys. Particulars as to sectional area, electrical properties, weight, and copper equivalent, etc., are given, and some interesting information on casting, spinning, welding, pressing, polishing, etc.

A Commercial Exhibition of Foundry Plant.

The new works of Messrs. J. W. Jackman & Company, Limited, at Blackfriars Road, Manchester, and within easy reach of the centre of the City, include the usual business offices, and at their rear a main shop 150 ft. by 50 ft., with side galleries and annexe. The floor is served by a 3-ton Herbtrt Morris crane. The offices and works are heated by hot water and lighted electrically. All the machintry is also motor-driven, power being taken from the Corporation mains.

An interesting feature of the installation is that the whole of the machines may be seen in actual operation, and as those installed are representative types of English, German and American practice, it is possible to make a side-by-side comparison of their particular merits, which hitherto has not been possible.

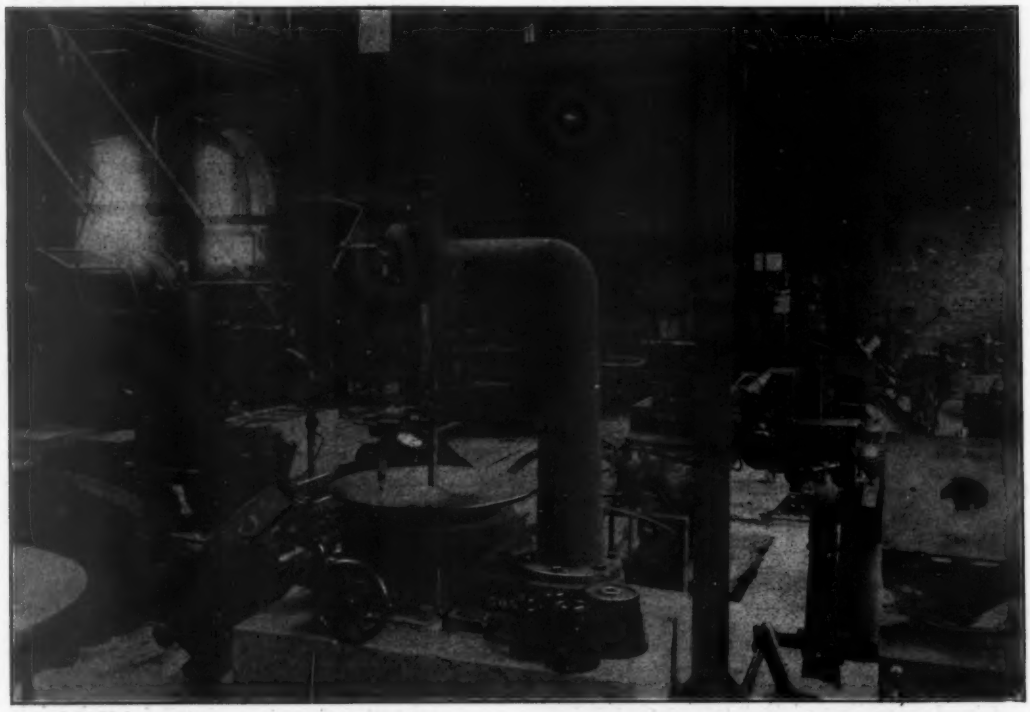


FIG. 1.—VIEW IN MACHINE-MOULDING DEPARTMENT, SHOWING GEAR-WHEEL MOULDING MACHINES IN THE FOREGROUND.

In the moulding department the machines naturally are a very imposing feature; they include various types of hydraulic and pneumatic machines for pressing the sand and removing the pattern, jolt-ramming and rock-over machines, hand machines for pressing moulds and removing patterns, Pridmore machines of different types, various forms of turnover machines, machines for moulding gear wheels and pulleys of all sizes, and a number of machines designed for special work, such as pots, kettles, etc. Core-making machines for straight regular sizes and also for irregular cores of various sizes, are other features.

Combined moulding press and stripping plate machines have hitherto been objectionable, because the patterns which are usually supported by a toggle joint will spring under pressure. In the Farwell Universal moulding machine, of which many types are shown, this objection has been removed, as the pattern rests firmly upon the stationary press table, and is entirely independent of the lift table. The sole function of the lift table is to lift the mould and stripping plate off the pattern after it has been pressed, this lift table being guided in its vertical movement by a single long slide which is adjustable to take up wear and fully protected from the sand. This type of machine may be used as a combined moulding-press and stripping-plate machine, as a combined moulding-press and flask-lifter without stripping plate, or as a plain moulding press. When used with a stripping plate, the pattern plate to which the patterns are secured rests firmly upon the stationary press table, the stripping plate resting firmly upon the pattern plate. Three or four studs are secured to the stripping plate, which extend down and rest upon the lift table; these studs engage with guides on the pattern plate and guide the stripping plate in its vertical movement.

When iron flasks are used, a sand frame or flask upset is placed upon the top of the flask, which increases the depth of the flask sufficiently to hold the additional sand necessary to secure the required pressure when the bottom board and presser head are forced in. After ramming, this sand frame is removed and the mould struck off level. In these machines the lever is in a horizontal position when pressing the mould, the advantage of which arrangement will be obvious;

the lever is also adjustable to conform with the size of the mould and the weight of the operator. Moulds up to 18 in. by 22 in. or 16 in. by 24 in. can be pressed with ease, the ratio of leverage being 30 to 1 with full length of lever, whilst when the lever is properly set, every mould receives the required pressure, without dependence upon the judgment of the operator.

Another machine of which mention may be made is the hydraulic moulding machine with turnover pattern plate, traversing press head and mould carriage. In this machine the pattern plate revolves in trunnions supported by fixed standards; the press head runs on a carriage which is brought forward for ramming and moved back whilst the boxes are filled. The box-carrying truck also runs on rails to facilitate handling the finished moulds. The patterns are mounted on either side of the turnover plate. The top and bottom boxes are clamped in position on either side of the pattern plate, a sand frame is placed on the uppermost box, which is then filled with sand, the press head is run in and the pressure applied, the ram forcing the box truck and boxes against the press head. After the pressure is relieved the sand frame is removed, and the box struck off; the pattern plate is then turned over and the operation repeated with the other box. The first box is then unclamped and descends with the ram on the box truck, which is drawn forward whilst the pattern plate is turned, and a new top box placed in position, so that in operation there is always above the pattern plate a box to be

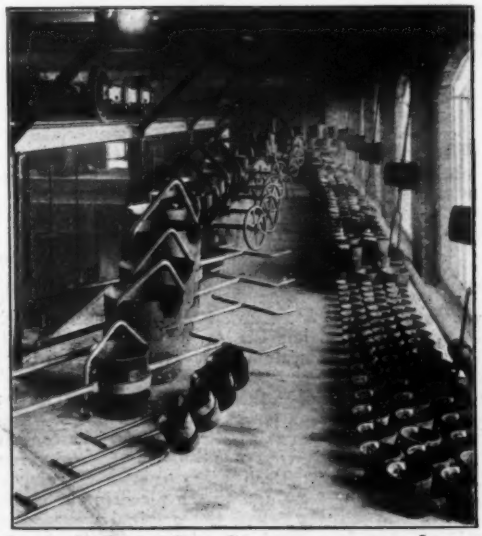


FIG. 4.—VIEW IN SIDE GALLERY, SHOWING LADLES.

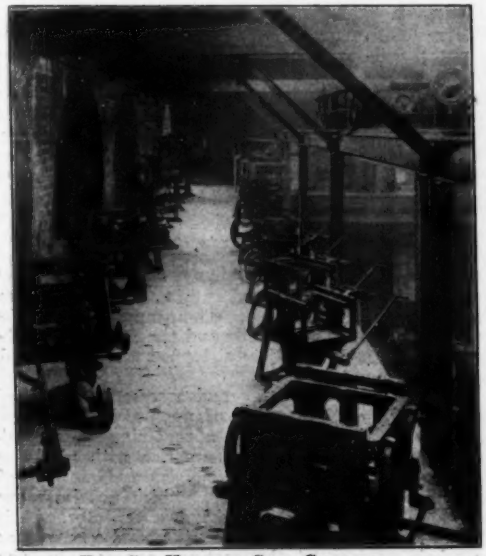


FIG. 5.—VIEW IN SIDE GALLERY.

FIG. 6.—VIEW IN SAND-BLAST APPARATUS DEPARTMENT.

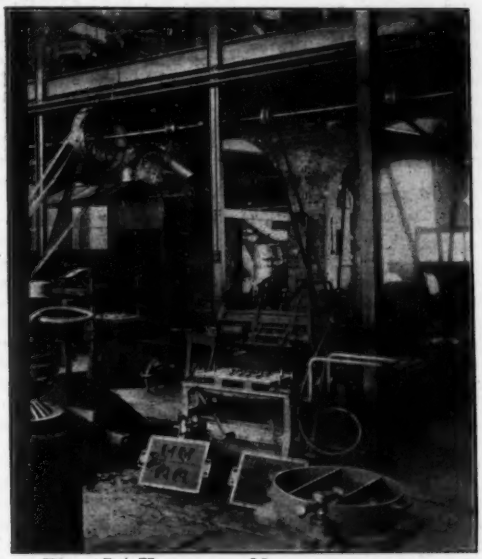


FIG. 7.—VIEW IN MOULDING-MACHINE DEPARTMENT.

filled and rammed, whilst one that has just been rammed remains below.

Adjacent to the moulding machines is a complete range of sand-preparing and sand-riddling machines, sand sifters, sand disintegrators and sand-mixing plants. Beyond these are brass-melting furnaces, stationary and tilting types in capacities up to 500 lbs. designed for coke, oil, or gas firing. Here also is a complete installation of the "Climax" cinder mill with magnetic separator, specially designed for treating cupola slag. This is a very compact little plant. The machine consists of a ball-grinding mill, into which the material is fed through a charging hopper. Enclosing the grinding mill there is a scouring drum by means of which the cinder is automatically separated from the metal, the latter passing to an outlet on the side of the machine opposite the hopper and the flour through an octagonal sieve and a bottom outlet to the magnetic separator. It will be seen that the whole operation of treating the cinder or slag is quite automatic. The machine being set in motion and fed until the knocking of the balls is faintly but distinctly heard, further material is fed at intervals until such time as the machine is fully charged with iron, when it is stopped and run in the reverse direction to discharge the iron. The magnetic separator delivers the flour on one side and the fine iron on the other, and it is automatically stopped when the grinding mill is emptying.

The sand-blast apparatus and accessories exhibited comprise five distinct types of apparatus in actual operation. Among these is a revolving-drum sand-blast machine. The common practice with machines of the revolving drum type is to spray a stream of sand from one or more nozzles, which nozzles move backwards and forwards as the drum rotates. It is claimed that this does not spray the sand evenly over the whole surface of the castings exposed in the drum, and to overcome this objection in this machine there has been introduced a slot jet, fixed axially, so that the rotation of the drum round the jet is unhindered, and the castings, as they are brought under the action of the blast, are operated on equally over the whole width of the drum. It is essential for efficiency that the jet should be adjustable, and this adjustability is a prominent feature of the machine referred to, whilst with the fixed slot-jet there are, of course, no movable air and sand pipes, and no hose couplings or joints. The air only meets the sand at a point near where it enters the jet, thus effecting a considerable reduction in the necessary air pressure, a pressure of from 15 to 16 ozs. giving perfect results. Air for the machine installed is supplied by a positive rotary blower. In operation the sand which has been projected against the castings falls through the perforated casing of the drum on to a wire screen which intercepts the foreign matter, such as moulding pins, etc., the sand passing through it to a worm conveyor, whence it is carried back by means of an elevator to the sand hopper, to be used over again; thus a continuous circulation and a perfectly even delivery to the jet is obtained.

Of the machines of the rotary-table type which are shown, the "Little Vulcan" is particularly suitable for the small foundry. The second machine of the rotary-table type is designed for larger work, but the following details are common to both. The air and sand are conveyed in separate pipes right to the spot where the work is done, the sand being conveyed to the blast nozzle by gravity only comes into contact with the air when it reaches the nozzle, thus the whole of the power of the compressed air is imparted to the sand. The sand is automatically screened twice before it passes into the nozzles, the second screens, which are placed above the nozzles and receive the sand from the elevator, being automatically shaken.

Not the least interesting feature of the apparatus referred to is the method adopted for extracting and dealing with the dust incidental to working operations. The machines are coupled up in two groups, the dust-laden air from Nos. 1, 2, and 4, being dealt with in one chamber, and that from Nos. 3 and 5 passing through a second extractor. Both extractors, which are of the centrifugal type, are coupled up to a common main, the air being drawn through this main by a simple exhaust fan, into a water seal, where the finest particles of the dust are intercepted. It will thus be seen that the dust does not come into contact with the fan. Emery wheels, dressing tables, pig-breakers, etc., are also shown in operation in this shop.

The feature of the gallery of the building is a varied assortment of ladles, core ovens, etc., whilst another room contains many forms of gate cutters, and other accessories. Here also is to be seen the Brinell machine for harness testing, for which Messrs. Jackman are sole British agents.

Storage of Foundry Patterns.

A system of pattern storage which has been developed by the Standard Sanitary Manufacturing Company, Louisville, U.S.A., is described in "The Iron Age." The system is based on the sorting of the patterns and compiling an index or key, which can be duplicated for the use of the several departments, and will then enable anyone to find a desired pattern. The patterns are listed under the factory's catalogue numbers, thus avoiding the necessity for a new arrangement. Each piece carries a reference to the catalogue page and to the place in the storage room where may be found the original wood master pattern, the iron master pattern or patterns, and the working patterns. For the purposes of this index, the patterns are classified into about 30 groups, according to their kind, and these again fall readily into other smaller groups, according to model, size, and the like. This at once gives a logical basis upon which to work, not only in preparing the index, but in the work of storing the patterns themselves. A list of these 30 classes has been prepared, and is posted in the storage room and in each department, where a book is used for ready reference, in order that the number of a given class may be ascertained at a glance. From this, reference is had to that particular section of the index where may be found under its proper catalogue number the piece whose pattern is desired. The pattern storage room is a two-storey building, about 60 ft. square. The storage is on racks, in double tiers or storeys. The racks run round the walls on the two rooms, and all of the floor space is taken up with them as well. Each rack is lettered, beginning with A and running to H on the first floor, and there is an equal number on the upper floor, beginning with the letter I. The racks, in turn, are divided into six sections of convenient length and the sections into shelves reaching from the floor to the top of the section. There are from 10 to 12 shelves to a section, depending upon the size of the patterns for which they are used. Reference to the place where a given pattern is stored is thus a simple matter. All that is needed is the rack letter, with the section and shelf number—as A-6-9, meaning Rack A, Section 6, Shelf 9—and it requires but a moment to lay hands on the pattern wanted. As a matter of convenience in handling, the working patterns, for which there are frequent calls, are placed on the ground floor, and the master patterns, both wood and iron, which are needed only for the purpose of running new working patterns, are on the second floor.

Inventions.

Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

1912.

29,051. Manufacture of steel. Rombacher Hüttenwerke and J. I. Bronn.

29,377.*Making cores of any cross-section for metal casting. W. Kurze.

29,502. Cupolas. T. H. C. Homersham.

29,537 and 29,538. Separation, detection, and estimation of elements in alloys. A. L. Fletcher.

29,694.*Moulding boxes. K. Karchen.

29,720.*Multi-layer steel castings. (Akt.-Ges. der Briansker Schienen-Eisenhüttenwerke und Maschinen Fabriken, Russia.)

30,016. Iron moulds or chills for use in the manufacture of metallic bedsteads. G. A. Phillips and W. Molineaux.

30,079.*Manufacture of steel. N. E. Maccallum.

1913.

240. Metallic alloys. J. F. Duke.

277.*Furnaces. J. C. James.

412.*Process of casting. (Liquid Forged Steel Company, United States.)

423. Manufacture of chilled metal rolls. Brightside Foundry and Engineering Company, Limited, and F. W. Firth.

494.*Mechanically discharging metallurgical furnaces. Franz Meguin & Company Akt.-Ges. and W. Müllet.

544. Facing or milling machine. J. A. Paterson and Widnes Foundry Company, Limited.

1,092. Manufacture of manganese-bronze, and similar alloys. F. Heusler and British Mining and Metal Company, Limited.

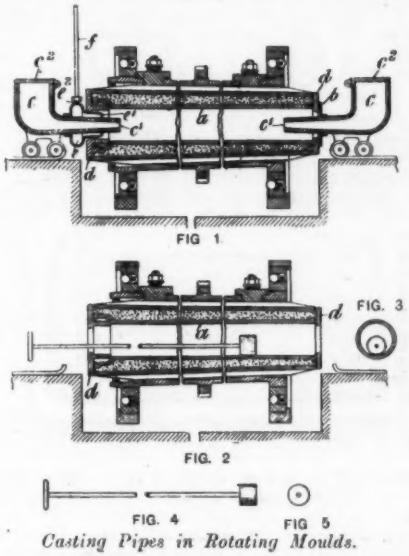
1,166.*Ingot casting and compressing machines. L. E. Howard.

1,306. Manufacture of steel. G. J. B. Chetwynd, Viscount Chetwynd.

1,326.*Apparatus for delivering molten metal. G. Mellen.

Abstract of British Patent Specifications recently accepted.

11,340 (1912). *Operation of Casting Pipes in Rotating Moulds.* J. Orten-Boving and H. J. Molinder, 9½, Union Court, Old Broad Street, London, E.C.—Fig. 1 is a longitudinal sectional-elevation showing methods of minimising the oxidation of the internal surface of the pipe, during the casting of the pipe, and the partial setting of the material; Fig. 2 is a corresponding section showing how, after the partial setting of the material of the pipe, extraneous matter is separated from the surface of the pipe and the surface rendered smooth; Fig. 3 shows a transverse section of a cutting tool for separating the extraneous matter; and Figs. 4 and 5 show a smoothing tool. A part of the patent is the same as Specification No. 23,835 of 1910. To exclude the entrance of air during and subsequent to the admission of the molten metal, a plate *b* is adjustably secured to the runner *c*, the plate *b* serving to close the annular aperture in the usual plate *d*, which otherwise would be available for the entrance of air around the delivery nozzle c^1 of the runner, the orifice being closed when the plates *b* and *d* are brought into contact After the measured quantity of molten metal which is poured into the runner has passed into the mould, the hinged-lid c^2 of the runner is closed. A similarly constructed and fitted runner may be provided simultaneously to deliver molten metal to the other end of the revolving mould. A modified construction of runner is shown applied to the other end of the mould whereby atmospheric air is excluded and means provided for the delivery to the mould of gas or vapour, which is either inert or possesses a reducing character such as carbon mon-oxide, for example. For this purpose a gas-chamber *e* is secured to the nozzle c^1 of the runner, which gas-chamber has a nozzle e^1 large enough to surround the nozzle c^1 of the runner and leave an annular space between the two nozzles for the passage of gas into the mould. The gas-chamber is supplied with gas

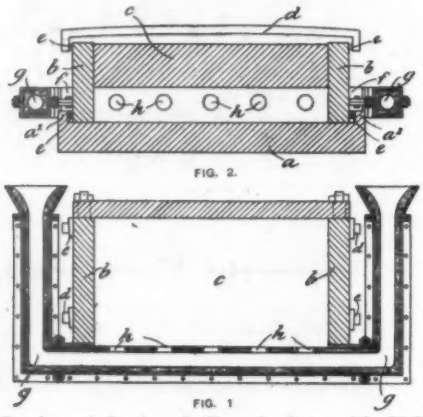


Casting Pipes in Rotating Moulds.

through a flexible pipe *f*, which is secured to the branch c^2 of the gas-chamber. Instead of forcing out atmospheric air and replacing it by gas through the medium of the gas-chamber *e*, the desired effect may be achieved by inserting in the mould, preparatory to supplying it with molten metal, a combustible substance such as wood, which will ignite by the heat of the molten metal and use up by its combustion the oxygen initially admitted with the air to the mould. The supply of oxygen being limited, the products of combustion will comprise carbon mon-oxide, which will have a reducing effect on any oxide which may be formed in the initial stage of the casting operation. The effect of the centrifugal force will be to cause slag and extraneous matter contained in the mould to come to and reside on the inner surface of the pipe, for the same reason that such matter rises to the top of a mould or into an easily detached riser leading therefrom, when casting a pipe in the ordinary way. Accordingly, in order to obtain a smooth lining for the pipe, the extraneous matter, which tends to adhere to the metal of the inner surface of the pipe, must be separated therefrom and removed. For this purpose, after the metal has set, but whilst it is still in a semi-plastic condition, the runners are withdrawn, for which purpose they are mounted on wheels which run on rails, and, through the apertures of the plates *d* at one or both ends, a tool formed with teeth, as shown in Figs. 2 and 3, is inserted to cut or abrade away the extraneous matter, the tool being moved from one end of the pipe to the other whilst the pipe is still rotating, though the speed of rotation may be reduced during this operation.

28,184 (1911). *Coating of Steel or Wrought Iron with Chilled Cast Iron.* E. L. Davies, Tregenna, Varde Road, Clydach S.O.—For this purpose the steel body is heated to a suitable degree for welding purposes, and so as not to chill the molten cast iron which is to be applied to it. The surface of the steel or wrought iron is coated with a thin film of a suitable flux consisting of a fusible silicate, and then placed in a chill mould, leaving a space of more or less width for the introduction of the molten cast iron. When a large surface of steel is to be so coated, the molten cast iron is introduced through a number of gits arranged along a dried loamed split pipe at the bottom of the mould, which is served by an upright pipe so as to have a head of molten metal, and thereby force the metal into the whole of the space

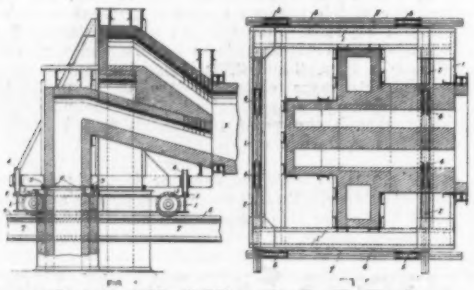
before it can set across the whole width of the space under the influence of the mould chills. The temperature to which the steel or wrought iron body is raised prior to the casting operation is preferably of the order of 1,100 degrees C. Fig. 1 is a longitudinal section, and Fig. 2 a sectional plan, showing a mould adapted for



Coating of Steel and Wrought Iron with Chilled Cast Iron.

surfacing a steel or wrought iron plate with chilled cast iron. The mould cavity is formed between a chill mould plate *a*, end plates *b* and the steel or wrought iron plate *c*, which, previously heated and coated with a flux, is to be surfaced with chilled cast iron. Suitable clamping devices are provided to hold these elements of the mould, as, for example, a clamp *d* and wedges *e*, which secure the end plates of the mould to the steel or iron plate *c*, the chill mould plate *a* being similarly used as a clamp by means of flanges a^1, between which and the side plates of the mould are driven wedges *e*. The bottom of the mould is constituted by a split tube or box *f*, having a dried loamed runner *g* extending longitudinally the whole length of the mould, and having gits *h* spaced along its length leading to the mould cavity.

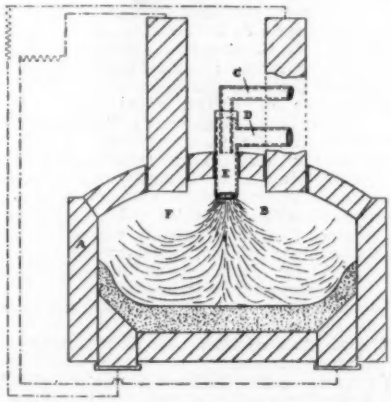
26,240 (1911). *Metal Mixers, Open Hearth Furnaces, etc.* B. W. Head, 47, Victoria Street, Westminster, London, S.W.—Fig. 1 shows in vertical section, and Fig. 2 in plan, a removable port block, or burner, arranged in accordance with the invention. The port block, or burner, is mounted upon an undercarriage 1 which is provided with rails 2 in lines at right angles to the central line of the mixer or furnace (a part of



Improved Metal Mixer, by B. W. Head.

the main body of which is indicated at 3). When it is desired to push the port block, or burner, up against the mixer or furnace, or to withdraw it, the undercarriage 1 is run on its wheels 5. When it is desired to draw the port block, or burner, sideways for repairs, or other purpose, it is run on its wheels 4 upon the rails 2 on the undercarriage 1_a and a track is provided upon the platform to coincide with the rails 2 on the undercarriage 1 at some convenient point in the motion of the carriage. The dippers of the seals (one of which is seen at 8) are arranged so as to be easily detachable from the port block, or burner. This can be done, as already proposed, by making them so that they surround each uptake separately and are secured by bolts 9, easily accessible for detachment and attachment.

26,184 (1911). *Metallurgical Furnaces.* V. Stobie, of the Stobie Steel Company, Warren Street, Sheffield.—The invention is illustrated in the accompanying cut, where A is an electric arc steel melting furnace, such as described in Specification 674/1911. B is the mouth of a suitable burner into which air under pressure arrives from pipe C. Pipe D delivers gas to the burner. The air and gas mix in the mixing chamber E and burn in the melting chamber F. When oil is used for the auxiliary heating, the gas burner illustrated is replaced by one suitably designed for the type of oil used. The above combination of oil or gas heating with electric heating in an ordinary electric steel melting furnace offers three advantages; the



Stobie's Improved Metallurgical Furnace.

first being in the cheaper melting of the raw materials, and the confining of the use of electricity to those portions of the processes which are more efficiently accomplished by its use; the second is in the increase in the neutral properties of the atmosphere in the furnace during the use of the electricity as the heating medium, this being accomplished by cutting off the air supply whilst maintaining thereto a small supply of gas or oil; the third advantage being in a diffused heat from the gas or oil for preparing the sole of the heating chamber.

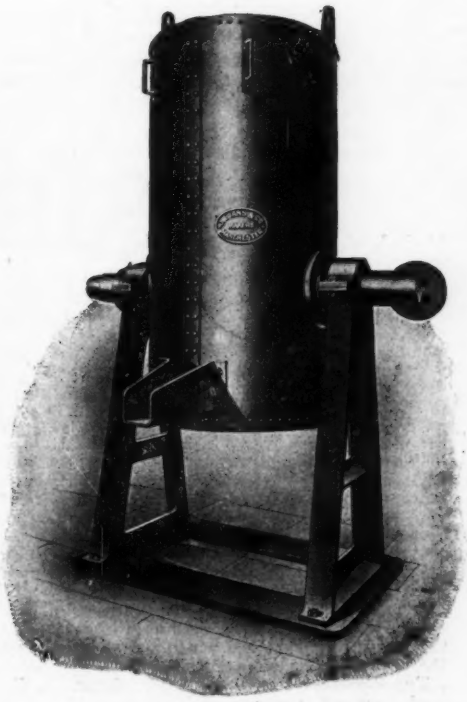
1,293 (1912). *Manufacture of Silicon or other Steels.* C. P. Williams, of The Gables, Lodge, Wrexham; and The Brymbo Steel Company, Limited, Brymbo.—The best plan for carrying out the invention is to bring a ladle, the capacity of which has been predetermined, suspended from a crane, under the runner trough along which trough the steel runs out of the furnace. The ferro-silicon is placed in this ladle (preferably before) (or as) the steel flows from the furnace into the ladle. The capacity of and charge in the furnace being greater than that of the ladle, the ladle is filled with steel before the furnace is emptied. The supported ladle is now moved off before the slag leaves the furnace, and the remainder of the metal in the furnace and the slag are run into another ladle on a casting carriage in the usual way. In the first or transfer ladle there is an alloy of steel and silicon free from basic slag. This ladle is carried to another empty ladle fitted with stoppers and nozzles and the steel is poured from the transfer or supported ladle into this empty ladle. This pouring brings about a vigorous action, thus causing the uniform mixing required, so that this steel is regular in quality. The ingots are then cast from this ladle in the usual manner.

AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.



James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Trade Talk.

GUEST, KEEN & NETTLEFOLDS, LIMITED, are extending their London Works, Smethwich, Birmingham.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, propose erecting a new shop at their Rugby works.

CONSIDERABLE improvements are being carried out at the Elton Works, Bury, Lancs., of C. Walmsley & Company, Limited.

WILMAN & COMPANY, LIMITED, engineers' furnishers, of Strand-on-Green, Chiswick, London, W., have removed to South Street, Isleworth, W.

MESSRS. J. & P. HILL are carrying out extensive improvements to their Ordnance Works, Sheffield, including an elaborate block of offices.

THE IVORITE NICKEL ELECTRO FOUNDRY, LIMITED, is being wound up voluntarily, with Mr. H. H. Hobart, 22, Basinghall Street, London, E.C., as liquidator.

ON Saturday, January 25 last, the Junior Institution of Engineers visited the Houses of Parliament, for the inspection of the arrangements for heating, ventilation, etc.

MR. B. J. ALLISON, Tower Chambers, 118, London Wall, London, E.C., has been appointed London representative of Wiltons Engineering and Slipway Company, Limited, Rotterdam.

MESSRS. P. JENSEN and C. A. JENSEN, carrying on business as engineers, patent agents, etc., at 77, Chancery Lane, London, under the style of Jensen & Son, have dissolved partnership.

HENRY BERRY & COMPANY, LIMITED, of Hunslet, Leeds, have placed their London business in the hands of Lawler, Ayers & Company, Limited, 1, Broad Street Place, Finsbury Circus, E.C.

THE trustee of the sequestrated estates of H. J. Miller & Company, engineers, 54, Gordon Street, Glasgow, and H. J. Miller, sole partner, intimates that a first and final dividend will be paid on February 20.

THE partnership heretofore subsisting between Messrs. E. P. Carter and G. E. Carter, carrying on business as brass casters, at Charles Henry Street, Birmingham, under the style of G. Price & Company, has been dissolved.

IN the Chancery Division, on January 21, Mr. Harman mentioned the petition for confirmation of the proposed reduction of capital of Turner, Naylor & Company, Limited, of Sheffield. His Lordship confirmed the resolution.

MR. W. J. HUTCHISON, of Newcastle, has taken over the iron foundry and engineering works carried on at Millbank, Thurso, by Messrs. James MacKidd & Son, for many years, and will restart the works this month.

THE works of Ernest Scott & Mountain, Limited, at Gateshead, have been purchased on behalf of Messrs. C. A. Parsons & Company, of Heaton Works, Newcastle-on-Tyne, together with the more important portions of the plant and machinery and the goodwill.

THE partnership heretofore subsisting between Messrs. G. Rushton & J. W. Parke, carrying on business as brass founders and finishers, at 111 & 113, Bolton Road, Darwen, Lancashire, under the style of George Rushton, has been dissolved. Mr. G. Rushton will continue to carry on the business.

THE members of the Dudley Tool and Ironworks Company, Limited, will meet at 83, Colmore Row, Birmingham, on February 11, for the purpose of having an account laid before them showing the manner in which the winding-up has been conducted and the property of the company disposed of.

THE discharge from bankruptcy of Mr. H. Robinson, steel merchant, carrying on business at 17 and 18, Prudential Buildings, Pinstone Street, Sheffield, has been granted, subject to his consenting to judgment being entered against him by the Official Receiver for the sum of £40, and £1 10s. costs.

THE co-partnership of George Caird Parker & Company, ironfounders' agents, 13-15, Waterloo Street, Glasgow, of which Mr. John Caird Parker and Mr. John Parker were the sole partners, has been dissolved by the retirement of the former. The latter will continue the business under the same name.

AT meetings of the shareholders of the Victoria Iron and Steel Company, Limited, Coatbridge, which has been taken over by the Scottish Iron and Steel Company, Limited, a resolution was passed and confirmed for the voluntary winding up of the company, Mr. Hugh Crichton and Mr. James A. Martin being appointed liquidators.

THE reconstruction of John Musgrave & Sons, Limited, Globe Iron Works, Bolton, who have been in liquidation for twelve months, was again considered at a meeting of debenture-holders at Bolton on January 6. Stock amounting to £68,000 was represented at the meeting, and authority was given to form a new company, the debenture-holders being secured in full.

THE BRYAN DONKIN COMPANY, LIMITED, of Chesterfield, have now transferred the commercial side of their business to the new offices which they have built at one side of the gateway entrance to the works. The site occupied by the old offices has been given over to the stores, and the space formerly taken up by the last-named has now been thrown into the main machine shop.

AT a meeting of the creditors of the St. John's Foundry Company, Perth, on December 30, 1912, a statement of affairs was submitted showing liabilities amounting to £4,396 and net assets valued at £4,208, leaving a deficiency of £128. The meeting elected Mr. W. B. Sievwright, accountant, Perth, as trustee, and it was unanimously agreed that the business should be carried on by the trustee until the next meeting of creditors.

AT a meeting of the members of the Thornton Engineering Company, Limited, the following resolution was duly passed :—"That it is expedient to effect an amalgamation of this company with Sugden's (Bradford), Limited, and that with a view thereto this company be wound up voluntarily, and that Arnold Hooper, of Old Bank Chambers, in the city of Bradford, chartered accountant, be and he is hereby appointed liquidator for the purpose of such winding-up."

THE annual report of the Machine Tool and Engineering Association states that, after meeting all current liabilities, the balance in hand amounted to £3,954, of which it is proposed to invest £3,000. The directors do not recommend the payment of a dividend, as they consider it necessary that the association should have ample funds at command for future requirements. It has been decided to transfer the offices of the association to Queen Anne's Chambers, Broadway, Westminster, S.W.

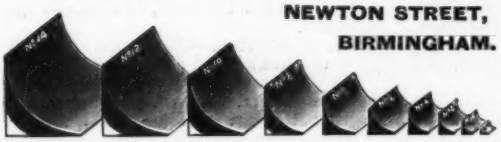
MR. H. A. SIMMONDS, trading as F. H. Simmonds, brassfounder, 22 & 24, New Charles Street, Goswell Road, E.C., applied on January 21 for his order of discharge from bankruptcy. The Official Receiver reported that the proofs of debt and the probable claim together amounted to £1,106 12s. 6d. The assets, which were estimated to produce £286 6s. 10d., had realised £144 14s. 4d., and nothing further was expected. The order of discharge was suspended for the minimum period of two years.

THE council of the Society of Engineers (Incorporated) may award in 1913 a premium of books or instruments to the value of £10 10s., for an approved essay on "A Scheme for the Registration of Engineers, including particulars concerning the Registration of Engineers in British Colonies and Foreign Countries." The competition is open to all, but, before entering, application for detailed particulars should be made to the secretary, 17, Victoria Street, Westminster, S.W. The last date for receiving essays is May 31.

PLOWRIGHT BROS., LIMITED, of Chesterfield, have recently completed an important addition to their Brampton Iron Works, where for a considerable time work in the constructional department has been very congested, all the available space on that side of Shipley Street being covered. The company, however, were able to purchase a considerable tract of land on the opposite side of the street, where their foundry and offices stood. The offices, however, had to be pulled down to enable the best use to be made of the land. The new managerial buildings, a feature of which is the spacious and well-lighted drawing office, front on to one end of the new constructional shop. This shop is covered by one bay 152 ft. by 58 ft., the floor being served by a Booth 10-ton electric crane. The company are at present building a four-pot crucible furnace, which will enable them to make their own steel castings up to 3 cwts. in weight.

WALTON & CO.

NEWTON STREET,
BIRMINGHAM.



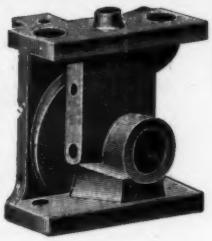
Leather Fillet of very best quality.
Large stocks kept.
Very advantageous prices.
Samples on request.

CUPOLA BRICKS

FOR LINING
ORDINARY AND PATENT
CUPOLA FURNACES.

JOHN R. FYFE & Co.,
SHIPLEY, Yorks.

YOU CAN CUT DOWN COSTS ON COMPLICATED SMALL PARTS



¶ To obtain such a part as that illustrated above by ordinary methods of casting would entail an amount of time and money out of all proportion to the profit you should make on in

¶ Why not secure the extra profit and the certainty of scientific precision that is offered you by using - -

"Prana" Die-Finished Castings?

Holes, Slots, Teeth, Notches, Screw Threads, etc., are accurately cast — no machining. Send for Booklet F., mentioning this paper, to

AERATORS LIMITED
EDMONTON, LONDON, N.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE
BRITISH
ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

Deaths.

THE death is reported of Mr. J. Houston, of the firm of J. and R. Houston & Kerr, Limited, engineers and ironfounders, Greenock.

MR. GEORGE MCONIE, senior partner of the firm of G. and J. McOnie, engineers and ironfounders, Greenock, died on January 12, in his 77th year.

THE death is announced of Mr. P. Wilson-Browne, a director of the Valor Company, Limited, and the Ast... Brass Company and Whitehouse, Limited.

THE death is reported of Mr. S. G. Chew, of Messrs. T. L. Chew & Sons, engineers, of King Street, and Bat... Street, Stroud, Gloucestershire, at the age of 73 years.

MR. WILLIAM CURRIE, a director of David Colville & Sons, Limited, Dalzell Steel and Iron Works, Motherwell, died on December 29 last. The deceased had been with the firm since its commencement.

THE death has occurred of Mr. E. Manisty, M.I.C.E., who in 1878 became protprietor of the Dundalk Ironworks, which he personally managed until 1888, when he became connected with the construction of the Eastham section of the Manchester Ship Canal.

THE death has occurred at his residence, Eden Hall, Penmaenmawr, North Wales, of Mr. Robert Dempster, C.E. The deceased, who was in his 85th year, was the founder of the firm of gas engineers and contractors, trading as Robert Elland & Sons, Limited.

THE death has occurred of Mr. John Morton, who was recently elected assistant secretary to the Associated Ironmoulders of Scotland. The deceased gentleman was a comparatively young man, and took a keen and enthusiastic interest in all that pertained to the good of the Association.

THE death is reported, at the early age of 36 years, of Mr. A. F. Donaldson, a director of Barclay, Curle & Company, Limited, shipbuilders and engineers, Glasgow. The deceased was a son of the late John Donaldson, of Donaldson Brothers, shipowners, Glasgow, and joined the firm of Barclay, Curle & Company in 1902. He was elected a director in 1908.

THE death is announced, in his 54th year, of Mr. W. B. Railton, who up to two years ago was the senior partner in the engineering firm of Messrs. Railton, Campbell & Crawford, Cherry Lane, Walton, Liverpool. Prior to founding the present firm Mr. Railton was identified with Messrs. David Crawford & Company, Blackstone Street, Liverpool, which was one of the leading Liverpool engineering firms. Subsequently the style of this firm was changed to Messrs. Railton & Campbell, and later to its present style.

THE death has occurred, at the age of 71, of Mr. W. C. Parkinson, senior director of the firm of Parkinson & W. & B. Cowan, Limited, ironfounders and engineers of Birmingham, London, etc. The firm are one of the oldest in the country making gas meters, and the business was established in 1816 by Messrs. S. & J. Crosley. In 1847, Mr. Parkinson's father, who had been engaged with the firm, took over the business, which subsequently became known as W. Parkinson & Company. This concern absorbed the business of John Bent & Son, Birmingham, and later that of W. & B. Cowan, Limited, when the title of Parkinson and W. & B. Cowan, Limited, was adopted.

MR. ARTHUR CROZIER CLAUDET, A.R.S.M., F.I.C., M.Inst.M.M., died at his residence, Fitzjohn's Avenue, Hampstead, London, N.W. on January 17, after a few days' illness. He had previously contracted a somewhat severe chill, but had been in the City daily until a week before his death. The cause of death was pneumonia. Mr. Claudet, who was 57 years of age, was the head of the well-known firm of assayers and metallurgists which has been established in Coleman Street, London, E.C., for many years, he having succeeded his father in that position on the death of the latter in 1905. The firm have for long been assayers to the Bank of England, the Royal Mint Refinery, etc., and Mr. Arthur Claudet had conducted the business for a number of years prior to his father's decease. Mr. Claudet was an original member of the Institution of Mining and Metallurgy, of which he was treasurer.

New Companies.

IMPROVED CASTING SYNDICATE, LIMITED.—Capital £3,000 in £1 shares.

D. F. AND M. ENGINEERING COMPANY, LIMITED.—Capital £1,500 in £1 shares.

STRINGER & COMPANY, LIMITED.—Capital £8,000 in £1 shares, to carry on the business of steel manufacturers, etc.

CECIL ENGINEERING COMPANY, LIMITED.—Capital £2,000 in £1 shares. Registered office: 10, King Street, Cheapside, E.C.

VILLIERS ENGINEERING COMPANY, LIMITED.—Capital £15,000 in £1 shares. Registered office: Upper Villiers Street, Blaberhall, Wolverhampton.

HARLING & TODD, LIMITED.—Capital £20,000 in £1 shares, to carry on the business of iron and brassfounders. Registered office: Rosgrove Ironworks, Burnley.

MIDLAND ENGINEERING COMPANY, LIMITED.—Capital £100 in £1 shares.

JOHN PRICE, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of engineers.

VACANI SYNDICATE, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of ironfounders.

LONDON REFINING COMPANY, LIMITED.—Capital £2,000 in £1 shares. Registered office: 32, Clerkenwell Road, E.C.

STRODE & COMPANY, LIMITED.—Capital £20,000 in £1 shares (5,000 preference), to carry on the business of engineers. Registered office: 48, Osnaburgh Street, N.W.

JAMES HARVEY, CHILD & COMPANY, LIMITED.—Capital £1,000 in £1 shares (500 "A" and 500 "B"), to carry on the business of engineers. Registered office: 52, Queen Victoria Street, E.C.

BOLTON MOOR FOUNDRY COMPANY, LIMITED.—Capital £5,000 in £1 shares.

BRITISH LION ENGINEERING COMPANY, LIMITED.—Capital £2,000 in £1 shares. Registered office:—276, Fratton Road, Portsmouth.

PATTERN MAKERS (ENGINEERING) COMPANY, LIMITED.—Capital £2,500 in 1,200 cum. pref. shares of £1 and 260 ordinary shares of £5. Registered office:—63, Queen Victoria Street, E.C.

NEWTON & NICHOLSON, LIMITED.—Capital £15,000 in £1 shares, to take over the business of a metallic packing manufacturer, engineer and stamper, carried on by Mr. J. S. Nicholson, at Tyne Dock Corrugated Metallic Packing Works, South Shields, as Newton & Nicholson. The first directors are Mr. J. S. Nicholson and Mr. J. N. Nicholson.

SMITH & COMPANY, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc.

C. GOODMAN & COMPANY, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of founders, etc.

WAKELIN & DENT, LIMITED.—Capital £3,000 in 2,750 15 per cent. non-cumulative preference shares of £1 and 1,000 ordinary shares of 5s., to carry on the business of engineers, etc.

S. WOLF & COMPANY LIMITED.—Capital £26,000 in 10,000 preference shares of £1, 15,000 ordinary shares of £1 and 20,000 "B" shares of 1s., to carry on the business of ironfounders, etc. Registered office: 115, Southwark Street, S.E.

The BYNEA STEEL WORKS, LIMITED, of Bynea, near Llanelly, are putting in five melting furnaces (each of 50 tons capacity), together with gas producers and continuous furnaces, and Mr. G. P. Wincott, the well-known furnace builder, of 180, Attercliffe Road, Sheffield, has secured the contract. Amongst other work being executed by Mr Wincott at the present moment may be enumerated a new 40-ton furnace, with gas producers, new chimney, etc., for Jonas & Colver, Limited, of Sheffield; new 50-ton furnace and continuous furnaces, chimneys, etc., for the Monmouthshire Steel and Tinplate Company, Limited; tyre annealing and continuous furnaces, for Thomas Firth & Sons, Limited, Sheffield; new gas-fired tube plant for Howell & Company, Limited; and a new wire mill plant, consisting of annealing stoves, drying and blueing ovens, for Messrs. Shipman & Company, Central Wire Works, Sheffield.

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.

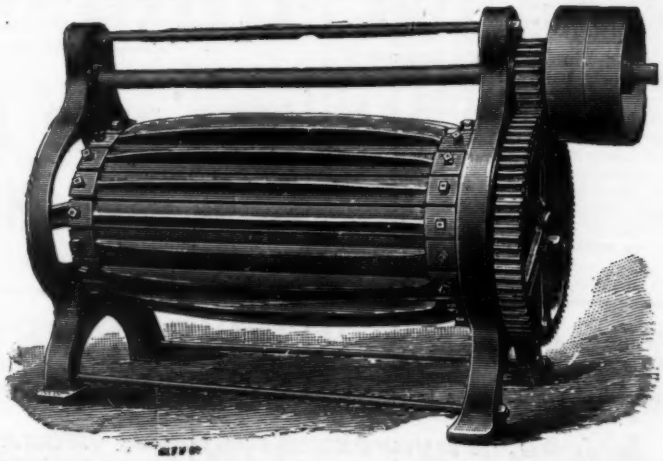
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

Metals.	End Jan., 1913.	End Jan., 1912.
Iron—Scotch pig warrants ton	*71/4½	*54/9
—Middlesbro' warrants ... ton	65 9	48 9
—W.C. M/nos Bessemer ... ton	86 6	67 0
—Stock, Scotch ... ... ons	1,000	1,000
Copper—Chili bars GMB ton	£69 2 6	£61 12 6
—Stock, Europe and afloat tons	43,160	68,670
Tin—English ingots ... ton	£233 10 0	£197 10 0
—Straits ... ... ton	£230 5 0	£194 10 0
—Stock, London, Holland, U.S.A., and afloat ...tons	14,875	17,218
Lead—English pig ... ton	£17 0 0	£15 17 6
Spelter—Ord. Silesian ... ton	£26 5 0	£26 2 6
Quicksilver (75lb)... bottle	£7 15 0	£8 5 0
Antimony—Regulus ... ton	£38 0 0 £40 0 0	£27 10 0 £28 0 0
Aluminium—Ingot ... ton	£89 0 0	—

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	7 7 6	to	7 12 6
Pipes, 1½ to 2½ in.	6 12 6	to	7 0 0
,, 3 to 4 in.	6 5 0	to	6 7 6
,, 5 to 8 in.	6 0 0	to	6 2 6
,, 10 to 16 in.	6 2 6	to	—
,, 18 to 24 in.	6 2 6	to	—
Chairs	4 14 0	to	4 15 0
Floor plates (open sand)	3 10 0	to	3 12 6

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 17s. 6d.; light wrought, £1 5s. 0d.; heavy cast, £3 3s. 6d.; all per ton, f.o.b., London. Copper (clean), £63 10s. 0d.; brass (clean), £43 10s. 0d.; lead (usual draft), £15 15s. 0d.; Zinc, £20 10s. 0d.; all per ton delivered merchant's yards.

Personal.

The late Mr. Charles D. Phillips, of the Emlyn and Central Ironworks, Newport, Mon., left estate of the value of £78,188.

Mr. W. T. Knaggs, the secretary of the firm of Sir B. Samuelson & Company, Limited, Newport Ironworks, Middlesbrough, has been the recipient of a presentation on the occasion of his retirement from the firm.

Mr. H. Hunt has resigned his position as works manager to Messrs. Smith & Coventry, and has become consulting and advisory engineer to Messrs. H. W. and P. Hunt, his sons, who have established themselves in business in Manchester.

The gross value of the estate of the late Mr. W. Bottomley, one of the first directors of Kelvin and James White, Limited, is £5,788.

The late Mr. H. Carrick, founder of the firm of Carrick & Wardale, engineers, of Redheugh, Gateshead, left estate valued at £5,233 gross.

Mr. F. H. Livens, a director of Ruston, Proctor & Company, Limited, Sheaf Ironworks, Lincoln, has just been added to the Justices of the Peace for that city.

Sir Hugh Bell (Chairman), Sir Archibald Geikie, Sir Maurice FitzMaurice, Sir William Ramsay and Mr. E. B. Ellington (President of the Institution of Civil Engineers) have been elected on the Advisory Council for the Glasgow Science Museum.

The late Mr. G. Jackson Smith, of Sheffield, retired steel manufacturer and merchant, formerly of Samuel Osborn & Company, Limited, left estate of the gross value of £60,222 4s. 9d., of which the net personalty has been sworn at £57,767 9s. 5d.

BLOFIL
THE
IRON CEMENT
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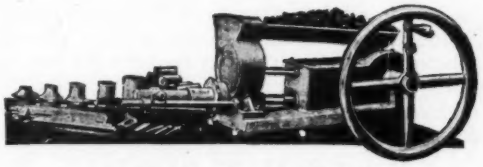

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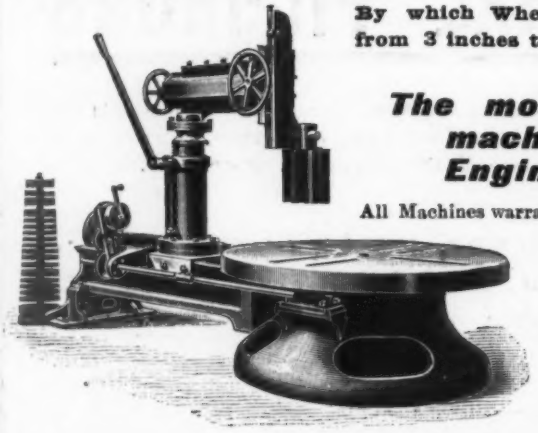

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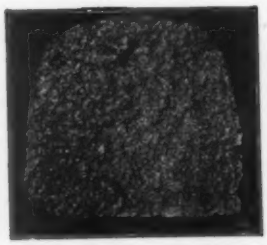

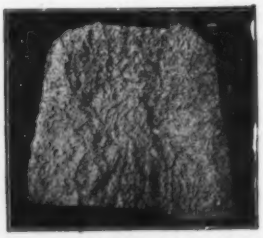

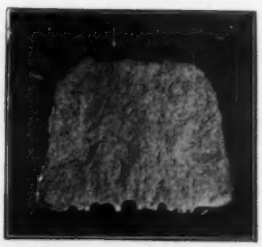

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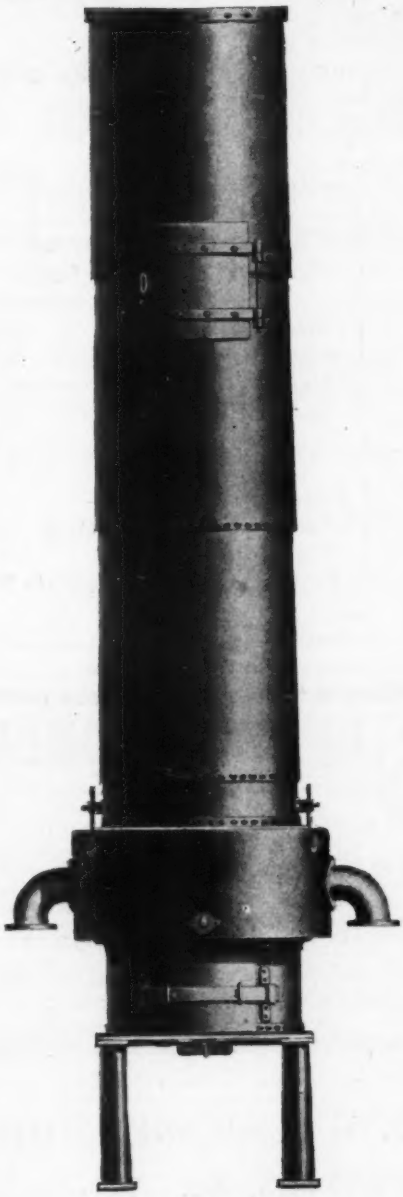

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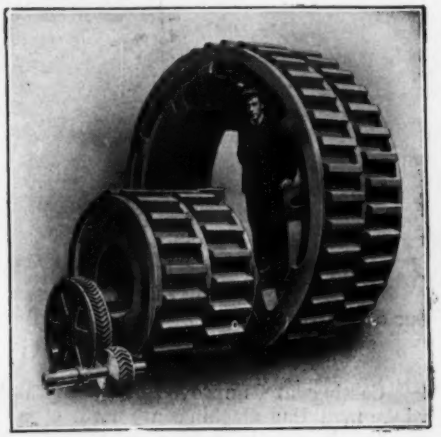

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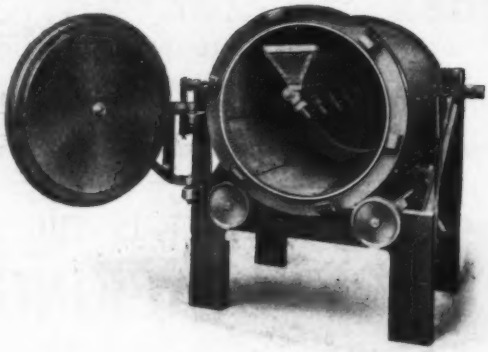
Write for Pamphlet.



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SAND-LIFT.
ABSOLUTELY
NO DUST.
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FRONT VIEW—OPEN,
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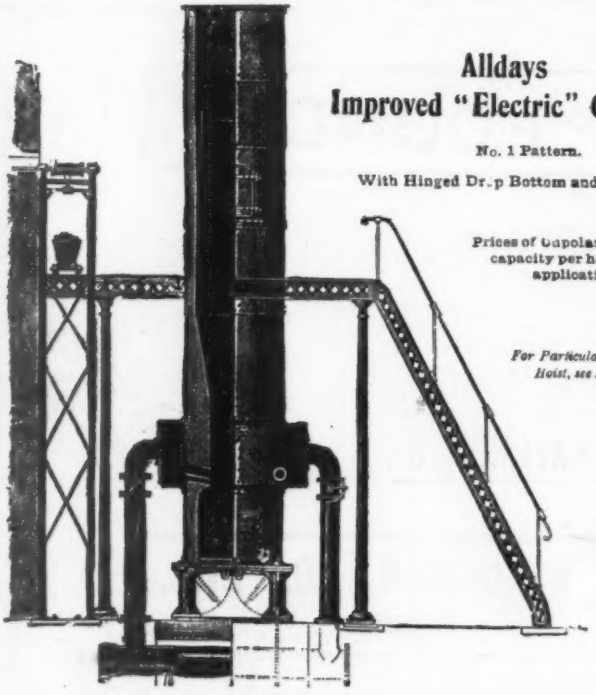

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No. 1 Pattern.

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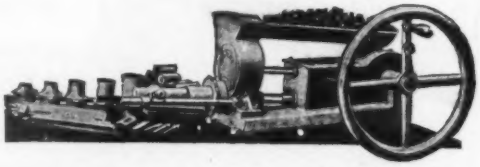

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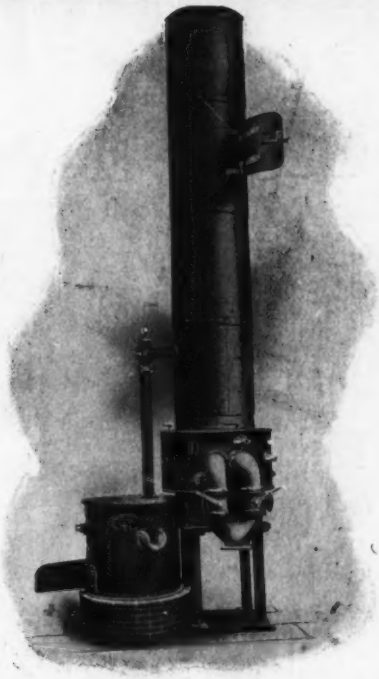

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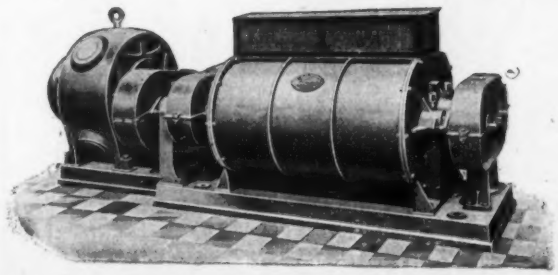

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